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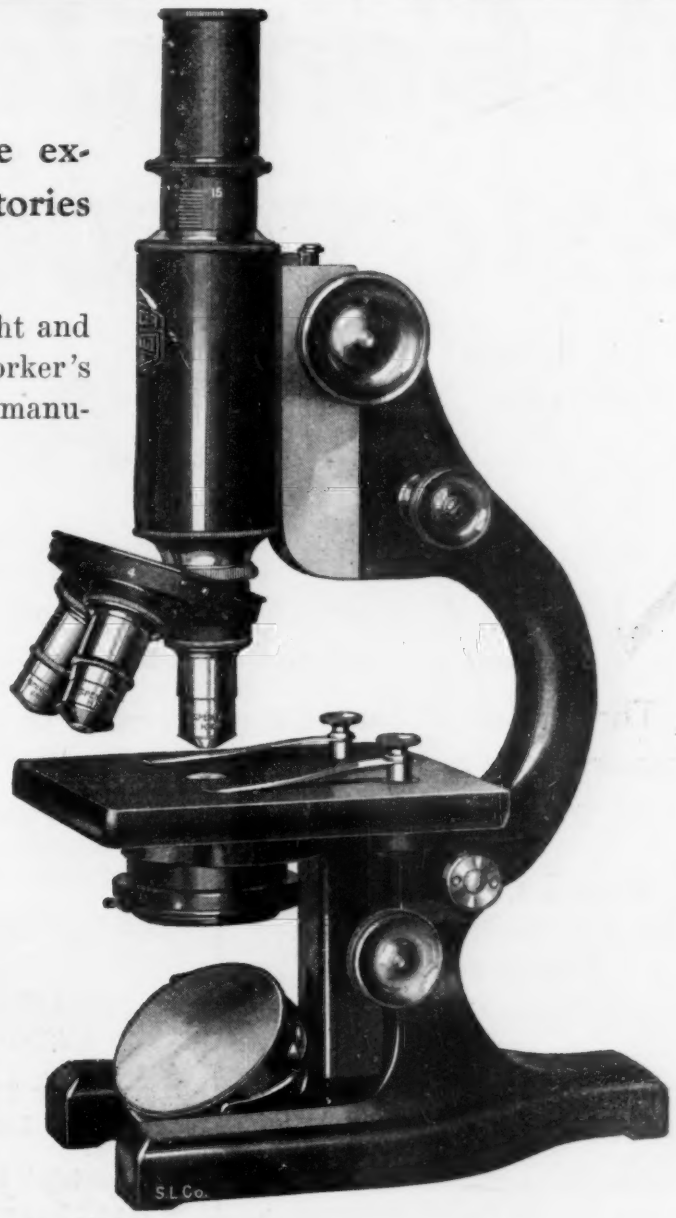

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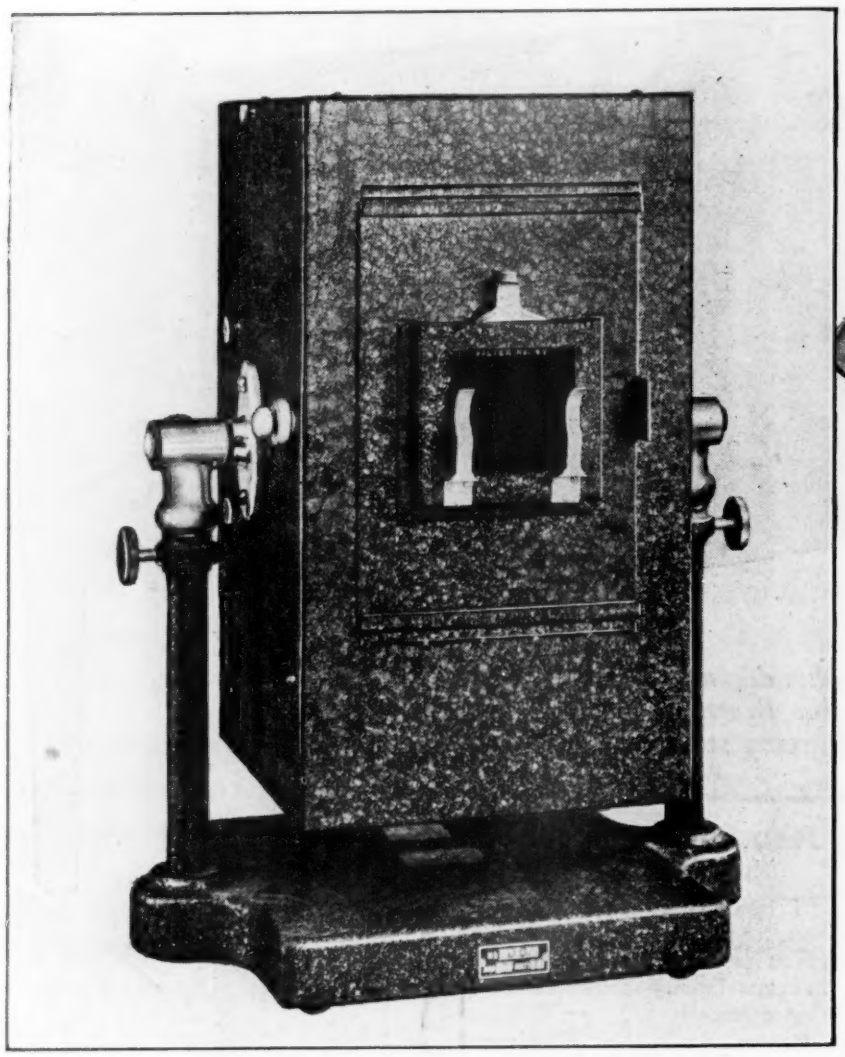

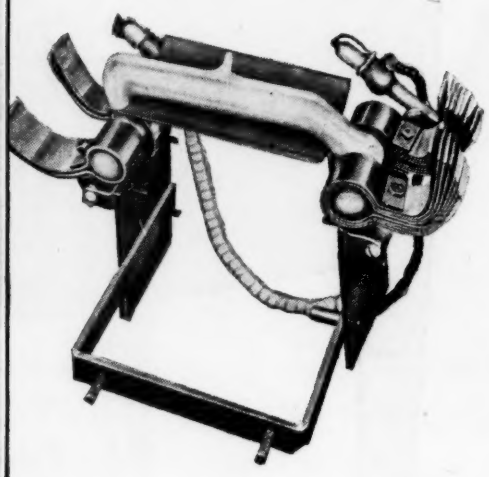

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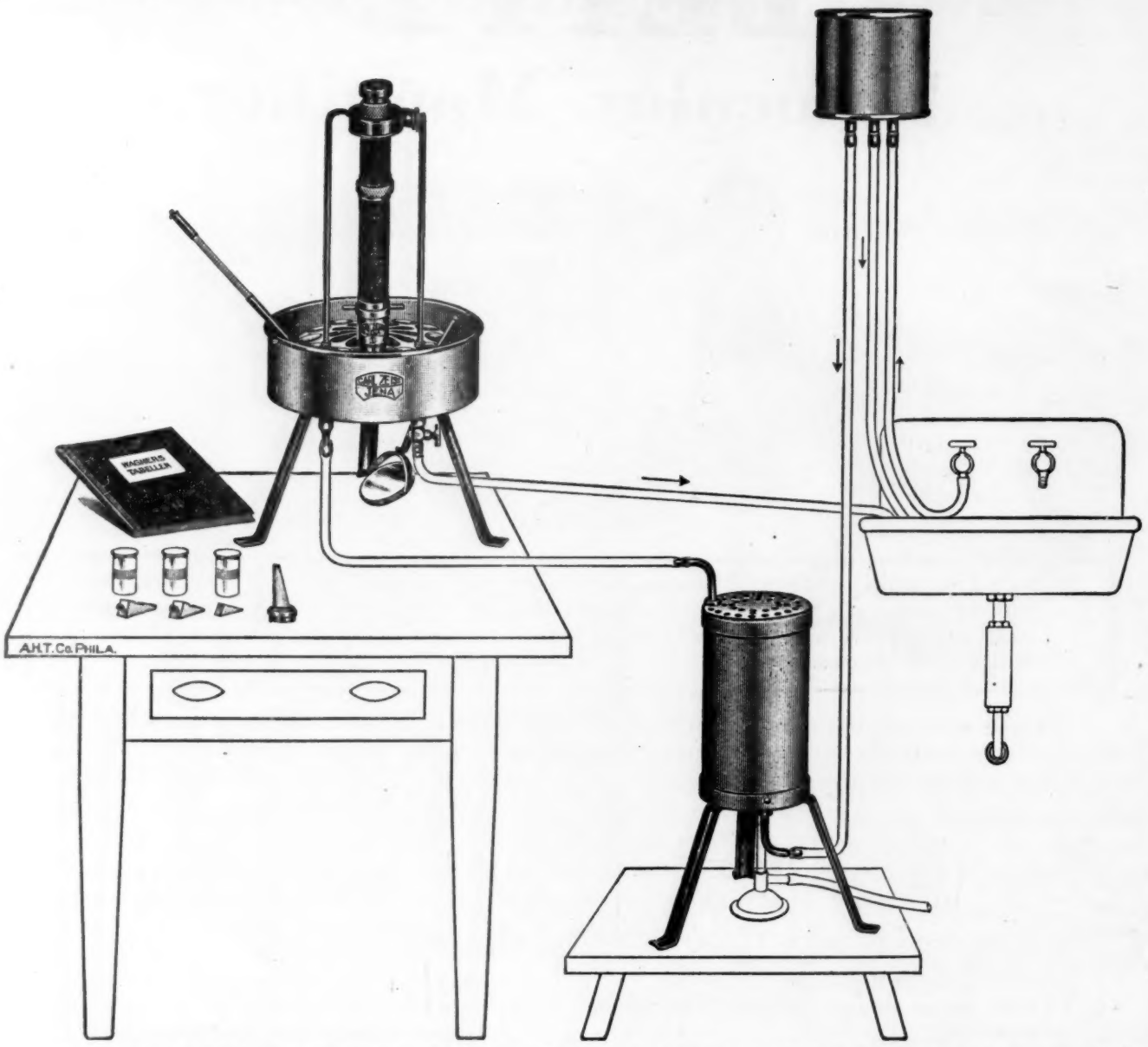

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SCIENCE

VOL. LXX — FRIDAY, SEPTEMBER 13, 1929 — No. 1811

The Second Celebration of the Twenty-fifth Anniversary of Research in the Carnegie Institution of Washington:
Addresses: DR. HENRY S. PRITCHETT, PRESIDENT W. W. CAMPBELL, CAPTAIN J. P. AULT, DR. WALTER S. ADAMS 243

Obituary:
Recent Deaths; Memorials 250

Scientific Events:
The King Prizes of the Peking Society of Natural History; The Beit Memorial Fellowships; Western Forest Fires; The New Building of the U. S. Department of Agriculture; Official American Delegates to the International Engineering Congress in Tokio 251

Scientific Notes and News 254

University and Educational Notes 257

Discussion:
The Origin of Chlorophyll and its Relationship to the Blood Pigments: DR. FRANK M. SCHERTZ. *Significance of Post-Illinoian, Pre-Iowan Loess:* DR. GEORGE F. KAY. *Peculiarly Shaped Hailstones:* PROFESSOR CHAS. T. KNIPP. *Mortality Statistics and the Length of Life:* J. T. RYAN 258

Quotations:
Sir Norman Lockyer and the Editorship of "Nature" 261

Reports:
The Census of 1930 262

Scientific Apparatus and Laboratory Methods:
Construction of Micro-thermocouples: D. M. WHITAKER 263

Special Articles:
The Earthworm Fauna of the United States: G. E. GATES. *The Relationship of Black Chaff Disease of Wheat to Certain Physical and Pathological Characters:* DR. L. R. WALDRON 266

Science News x

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THE SECOND CELEBRATION OF THE TWENTY-FIFTH ANNIVERSARY OF RESEARCH IN THE CARNEGIE INSTITUTION OF WASHINGTON

SECOND CELEBRATION

A FIRST celebration of this anniversary was held at the Department of Genetics of the Carnegie Institution of Washington, at Cold Spring Harbor, Long Island, on May 31, 1929, Dr. Henry S. Pritchett, vice-chairman of the board of trustees of the institution, presiding. Addresses delivered on this occasion by President John C. Merriam, Dr. Edwin G. Conklin, of Princeton University, and General John J. Carty, member of the board of trustees, appeared in the June 7, 1929, issue of SCIENCE.

A second celebration of the anniversary was held on board the non-magnetic ship *Carnegie* in San Francisco Harbor on August 26, the presiding officer being Mr. William Benson Storey, member of the board of trustees. The following addresses by Dr. Henry S. Pritchett, vice-chairman of the board of trustees; Dr. W. W. Campbell, president of the University of California; Captain J. P. Ault, commander of the *Carnegie*, and Dr. Walter S. Adams, director of the Mount Wilson Observatory of the institution, were delivered at this meeting:

Address by Dr. Pritchett

The Department of Terrestrial Magnetism of the Carnegie Institution is world-wide in its operations. It is the child of the Division of Magnetics of the U. S. Coast and Geodetic Survey and, as I happened to be superintendent of the survey in 1899 when its work was expanded so as to undertake a systematic magnetic survey of the country, I have been asked to give some account at this meeting of the work in ter-

restrial magnetism carried on by the Coast Survey and whose development led ultimately to the larger project for a magnetic survey of the whole world.

The Coast Survey, although formally organized in 1816, dates back to the days of Thomas Jefferson and his great Secretary of the Treasury, Albert Gallatin. Its original field of activity was defined by its title. It was a survey of the coast and its purpose was to aid commerce by providing accurate charts showing the configuration of the coast and the depth of the adjacent ocean, so that navigation might be safe to vessels of all descriptions. Its mandate from the government related to all the coasts under the domination of the government of the United States and its mission might almost be described in the words of the Corsair of Lord Byron,

> Far as the breeze can bear, the billows foam,
> Survey our empire.

For the first five or six decades of its history, it remained a coast survey, but even in that day the making of a nautical chart involved some knowledge of the magnetic forces on the earth's surface, for the compass was in constant use in navigation.

The strength and direction of the magnetic force in the earth's field in horizontal and vertical planes are referred to as magnetic elements and vary from place to place, having also a slow progressive change from year to year. From its earliest work, therefore, the Coast Survey had to concern itself with the determination of the magnetic elements along the coast and of their changes. The primary purpose of such observation was to serve the needs of navigation and of survey. It is interesting to note that in our day air navigation imposes a still sharper demand for accurate knowledge of the magnetic elements.

As time passed, and the whole continent of the United States became settled and occupied, it became clear that a triangulation and a magnetic survey of the whole country would be necessary. The Coast Survey, therefore, was ordered to assume the functions of a Coast and Geodetic Survey in order that it might meet this continental need.

Up to the beginning of the present century the work of the survey has been confined mainly to these observations of the magnetic elements for the direct service to the navigator and to the surveyor. It became clear, however, by that time that it would be necessary to carry out not only a far more extensive survey of the whole United States, but that permanent magnetic observatories should be established for continuous observation of the magnetic forces. This was the situation when I came to the survey in 1897.

In the general examination of the various departments of the work of the survey which the President and the Secretary of the Treasury had desired me to make, the question of the magnetic survey was involved. In consultation with my colleagues of the Coast Survey, we decided to ask Dr. L. A. Bauer, who had formerly been connected with the survey under Mr. Schott, to make a report on the state of our knowledge of terrestrial magnetism and to indicate the sort of organization which, in his judgment, might be set up in the Coast Survey to deal with this problem from the standpoint both of its scientific value and of its commercial applications.

Dr. Bauer submitted to the superintendent of the Coast Survey a plan which contemplated the observations of the three magnetic elements over the whole country at stations that were from thirty to forty miles apart. In addition to the stations in areas of magnetic disturbance, certain other stations were to be occupied for repeating the observations in order to determine the secular changes of the magnetic elements, and finally a limited number of magnetic observatories at fixed stations were planned where continuous observations of the United States magnetic field could be made and recorded.

The report of Dr. Bauer, after a full discussion by the scientific men of the Coast Survey, was recommended, practically in the form in which he offered it, to the Secretary of the Treasury who approved the plan and approved, likewise, the application to Congress for a sufficient appropriation to inaugurate it. This appropriation was granted by Congress and a new division, known as the Division of Terrestrial Magnetism, was set up in the Coast and Geodetic Survey in May, 1899. Dr. Bauer was invited to undertake this work and became the first director of the division. He had, as an associate, Mr. D. L. Hazzard, who succeeded him in the direction of the division of magnetics when Dr. Bauer resigned the work in 1904.

It ought to be said that the establishment of the division of magnetics, as well as the development of the Bureau of Standards from a small office of weights and measures, would not have been possible without the cordial and effective cooperation and support of the Secretary of the Treasury, Mr. Lyman Gage, and the Assistant Secretary, Mr. Frank A. Vanderlip. As Jefferson's great Secretary of the Treasury, Albert Gallatin, had stood back of the Coast Survey in its early beginning, so Mr. Gage stood back of it a century later in its effort to meet the growing needs in a nation that had expanded over a whole continent.

During the period following the creation of the new Division of Terrestrial Magnetism, five observatories were established and put in operation. Special buildings were erected for the observatories at Cheltenham, Maryland; at Sitka, Alaska, and at Ewa in Honolulu. Similar buildings were erected later in Porto Rico.

Besides fulfilling the immediate needs of our own country, the magnetic observatories of the Coast and Geodetic Survey have cooperated with other magnetic surveys and observatories throughout the world and have rendered important contributions not only to the practical work of surveying and of hydrography, but also to our knowledge of the nature of that mysterious magnetic field which surrounds the earth. The survey began also the determination of the magnetic elements at sea but, inasmuch as the observations were made on steel vessels, the difficulties of accurate results under such circumstances were very great.

Meantime it became clear that since the problems of terrestrial magnetism are world-wide, there would be necessary some organization of a study of the magnetic elements and of their variations over the whole world. When, therefore, the Carnegie Institution of Washington was founded in 1902, and its trustees invited various scientific men to suggest projects which they believed to be of great importance, Dr. Bauer presented a plan for a world-wide study of magnetics. His plan was adopted by the trustees of the Carnegie Institution and he was invited to undertake the direction of that work. In 1904, therefore, he transferred his activities from the Division of Terrestrial Magnetism of the Coast and Geodetic Survey to the Department of Terrestrial Magnetism of Carnegie Institution of Washington. This is a brief story of the process by which the Division of Magnetics, which began a hundred years ago in the Coast Survey for purely utilitarian purposes, has gradually resulted in the establishment of a world-wide survey of the earth's magnetic field. It is no small credit to the Coast and Geodetic Survey that out of its scientific work, planned originally for purely utilitarian purposes, there should have arisen two great scientific agencies like the National Bureau of Standards and the world survey of the magnetic field of the earth.

The earth is charged with negative electricity. Although this escapes constantly into the air, the earth's charge is never permanently diminished, nor is the charge in the air increased. How the charge thus lost from the earth is replaced has not yet been certainly explained and is perhaps one of the most important and far-reaching problems of atmospheric electricity still awaiting solution.

As an agency in the prosecution of this problem the non-magnetic ship, *Carnegie,* upon which we meet to-day, was constructed. Since magnetic iron in any form affects magnetic instruments, the *Carnegie* was constructed of wood with cotton fastenings. The small quantity of iron on board is in the engine room, far enough away to have no appreciable effect on the instruments. It has therefore been possible, through this specially constructed ship, to continue observations over a very large part of the United States surface where hitherto such observation could not be accurately made. That this service has been of enormous benefit not only to the mariner but also to an understanding of the forces of terrestrial magnetism can not be questioned. It is interesting to note that as this world-wide survey has gone on under the leadership of the Carnegie Institution, the Division of Terrestrial Magnetism of the Coast and Geodetic Survey has continued to cooperate with it in the most helpful manner. It is by such cooperation that science makes its constant progress. On this day, therefore, when we celebrate the twenty-fifth anniversary of the Carnegie Institution of Washington aboard this unique vessel, it is both a pleasure and a duty to record our indebtedness to the Division of Terrestrial Magnetism of the U. S. Coast and Geodetic Survey of which this great enterprise under the direction of the Carnegie Institution is a daughter.

HENRY S. PRITCHETT

Address by President Campbell

If I were asked to name and describe the most wonderful fact known to man, my reply would be:

So far as our observations and experiences go, every particle of matter in the physical universe is endowed with the property and necessity of obeying the fundamental laws of nature. Our universe of stars, our own star and our earth in all its parts, have been developed through long ages, to their present states, under the guidance and compulsion of perfectly definite and apparently simple laws. We have no reason to suppose that these laws are ever set aside, or varied in the slightest degree. The operations of those laws are believed to be never capricious or undependable. In fact, the arbitrary and the capricious do not seem to exist in physical nature. Whether the arbitrary and capricious exist in human nature is quite another matter, but that is a bridge we need not cross to-day.

This earth of ours, when measured in astronomic units of length and mass, is a mere bagatelle, a negligible thing; but when measured in terms of human dimensions this earth is a perfectly enormous body.

Cutting a little notch in the Culebra ridge at Panama, a ridge only three or four hundred feet high, to let the ships pass through—that was a huge undertaking. Not all the developed wealth of the entire United States would suffice to level off a few small mountain peaks at the edge of Lake Tahoe, and use the resulting materials to fill the cavity now occupied by the waters of that lake!

This great planet of ours is still responding, in major degree, to the forces, to the laws, which con-

trolled its evolution. There is nothing of greater importance to the well-being of the human race than that its universities and its other research institutions should determine the nature and the potency of those forces and the ways of those laws, so that the plans of man for doing the work of the world may be in harmony with them, and not in opposition thereto. Our engineers could compel the rapidly descending waters of a mountain stream to reverse their direction and go up hill, through pipes, to their source, but at what a heavy cost, day and night, day and night, and all to no good purpose. The same engineers could harness that stream and make its descending waters generate electricity and, by doing the work of the community, day and night, day and night, contribute to the comfort and happiness of men, women and children.

Now it took the people of this earth a very long time to learn a little something about electricity and chemistry and biology; and scores upon scores of able investigators are still finding out new things about those subjects; not really new things, not new laws and new principles, but old ones, immensely older than the hills, which had not yet been discovered—not yet uncovered—and brought to their notice and comprehension, and ours.

There are forces acting upon the earth whose effects are undoubtedly of great significance, but whose origin and laws are as yet very imperfectly known. I here refer especially to the subjects of terrestrial magnetism and terrestrial electricity. As this little pamphlet, recently issued by the Carnegie Institution, says:

> There exists about the earth a field of magnetic forces of which the origin is still unknown. The distributions and variations of this field present characteristics which are related not only to the magnetic and electric phenomena of the earth and its atmosphere, but also to solar and cosmic phenomena. The strength and direction of the earth's magnetism in the horizontal and vertical planes are referred to as the magnetic "elements," and these vary from place to place.
>
> An exact knowledge of the way in which they vary is demanded for the efficient use of the compass in maritime and aerial navigation; and a study of irregularities of distribution is one of the few means we possess for investigating the properties of subterranean masses. However, the values of the magnetic elements obtained at any point are not constant, but undergo periodic and irregular variations.

There is a diurnal variation in the pointing, a gradual shifting of the needle back and forth in a period of twenty-four hours, this diurnal shifting being greatest in summer and least in winter—obviously an effect, direct or indirect, of the sun's heat. There is another shifting of the needle, back and forth, in an average period of eleven years plus, which evidently bears intimate relation with the periodicity of the spots on the sun. Further, there is a long-period or secular change in the pointing of the needle. At the Greenwich Observatory, in southeastern London, the magnetic needle in the year 1570, when the long series of magnetic observations was begun, pointed 11° east of north; in 1660, ninety years later, its pointing was due north; in 1800 it pointed 24° west of north—a change of 35° in 230 years. Since 1800 the needle's pointing has been shifting easterly, until at Greenwich to-day the average reading is about 14° west of north.

Then there are two principal types of sudden fluctuations of the needle pointings:

First, those due to special conditions called "magnetic storms," which in their more intense forms are usually accompanied by aurorae, by electric currents of cosmic origin on our telegraph and telephone lines which for a few hours may prevent our use of them, and by especially active or large or numerous spots on the sun; and

Secondly, those due to the near presence of magnetic materials in the earth. In 1922, as the ship on which we were passengers was approaching the harbor of Broome, on the northwest coast of Australia, and through the courtesy of the captain on the bridge, we watched the ship's compass needle vary its pointing through 70° and back again in the course of not more than three or four minutes of time. We were apparently passing nearly over a great subterranean mass of metallic iron ore, or other materials possessing magnetic properties.

Now these extraordinary magnetic happenings had long been studied, but almost exclusively by individuals working alone, and on land areas forming but a minute part of the earth's surface. This problem of terrestrial magnetism, relating to the whole of the great planet upon which we reside, is accordingly an extremely extensive, complicated and difficult one. The first step toward its solution consists in the acquiring of the facts; the making of millions of accurate observations of the magnetic elements upon the surface of the continents and the seas, and of the electrical elements in the depths of the waters and in the heights of the air. To complicate the subject, observations already made, no matter when, do not continue to fit their points of observation: the magnetic elements at any point of observation vary with the passing of time, as already explained. The problem is entirely too large for an individual: it is a problem for an institution, a continuing institution, of great financial resource.

We have heard anew, on this anniversary occasion, about the establishing of the Department of Terrestrial Magnetism in the Carnegie Institution of Washington, under the leadership of Dr. Bauer, in 1904, with definite purpose and commendable courage, to

take up the study of this problem; and we have learned to-day about the good ships *Galilee* and *Carnegie*—something of their extensive cruises, back and forth, upon the seas, and just a little about the well-planned and well-executed activities of their staffs. The observations secured upon their decks have been supplemented, simultaneously, by similar observations made at thousands of land stations on all the continents except Antarctica. The very great number of accurate observations secured on land and sea and in the air and water have priceless value for the human race. The results thus far obtained from the study of these observations, results recognized by all students of the subjects as of very great importance, are but the first fruits of the heroic undertaking.

The commercial ships which are traversing the seas and making the whole world kin have during nearly two decades past been guided by charts whose magnetic elements are remarkably accurate, thanks to the work of the ship *Carnegie*. The staff of this ship upon which we are assembled discovered on its first cruises that the earlier charts used by the navigators were in error by astonishing amounts—approximately a degree as to the pointings of the compass in some parts of the intensively used north Atlantic trade route, and even as much as four, five and six degrees on some of the Pacific Ocean routes.

The extensive observations and the remarkable deductions on the subject of atmospheric electricity made by the department can scarcely fail to be of tremendous importance in the domain of radio transmission.

The knowledge gained by the Carnegie Institution in these fields will contribute generously to a better comprehension of some of the laws which have attended and will continue to attend the evolution of the earth; to a better understanding of the interrelationships of the earth and our sun, and quite likely to a better understanding of the interrelationships of our sun and its planets with the myriads of other suns in our own stellar system, and of our sun and its planets with the myriads of other great stellar systems as represented by the spiral nebulae distributed through wide space.

In closing, it gives me very great pleasure to express the conviction that no man ever made a better or more ideal investment in behalf of humanity's welfare than did Andrew Carnegie when he founded the Carnegie Institution of Washington. This is certified by the constant stream of dividends earned and distributed by the institution's many component parts which conduct investigations in the physical sciences, the biological sciences and the social sciences. Through the rich contributions made by the Carnegie Institution to our knowledge of these sciences we are being greatly assisted in putting ourselves in harmony with our surroundings on the earth and in the greater space above us, and we are bound to succeed the better in marching with the evolutionary current that is ever ready to serve us by joining forces with us.

W. W. CAMPBELL

UNIVERSITY OF CALIFORNIA

Address by Captain Ault

The plan of Dr. Louis A. Bauer, who organized this department twenty-five years ago, was to find out something more about the magnetic and electric state of this globe upon which we live, not only on the surface but also in the interior of the earth and in the air above and in the waters beneath the sea. The thinking and progressive mind could not ignore the challenge of the mysteries which surrounded the earth's magnetic and electric fields, not only in the fact of their existence but also in the untableted laws which seemed to govern their many and unusual variations and their relations, near and distant, to other terrestrial and cosmical phenomena. We make constant daily use of these mysterious manifestations of nature, in surveying, in sea and air navigation, in commerce, in manufacture, in telegraphic and radio communication and in countless other ways. We seek to broaden and extend this use and to brighten the dark places by added knowledge.

The chief accomplishment from a visible and tangible aspect has been the completion of a world magnetic survey, on land and sea, with its attendant contributions in geography, astronomy, meteorology and oceanography.

In this brief summary, the story of individual endeavor and enterprise, of invention and accomplishments can not be told. In the performance of this work many men visited practically all the countries of the world and the two vessels used in the ocean survey sailed many times over all the seven seas.

More than 180 expeditions have determined the values of magnetic elements at 5,800 land stations and 600 of these were repeat observations giving information as to secular-variations or change constantly taking place. The ten ocean expeditions have determined the magnetic values at 6,000 stations at sea, and secular-variation data have been secured at over 150 localities where cruises have intersected, involving from 2 to 10 stations at each intersection.

Continuous records of the changes in the magnetic elements have been made for ten years at our permanent observatory at Watheroo, Western Australia, and for seven years at Huancayo, Peru. These two observatories were established in the Southern Hemisphere to supplement the work of other observatories maintained by the different countries of the world, chiefly in the Northern Hemisphere.

The investigation of the earth's electric field has been confined chiefly to the ocean expeditions and to our observatories in Australia and Peru. The values of the atmospheric-electric elements have been determined daily at sea during the cruises since 1914 and continuous records of their variations have been made at these two observatories for about seven years.

Thus the department has fairly completed the picture of the distribution of the earth's magnetic and electric fields over the surface of the globe and many additional facts have been recorded concerning the laws which control the variations in these fields.

In addition to the virtual completion of this general survey on land and sea, may I briefly outline some of the more specific contributions to the physical sciences made by the department during the past twenty-five years.

First, in theoretical studies, much progress has been made in locating the causes of the earth's magnetic and electric fields and of their many variations which are constantly taking place, in establishing relationships between magnetic and electric and other cosmical phenomena such as polar lights, variations in radio conditions and changes in solar activity. Practically all variations in magnetic, electric, earth current, radio conditions on our globe and in polar lights can be connected with some activity on the sun. That these fields are modified when the sun's rays are cut off from a portion of the earth and of its atmosphere during a total eclise of the sun by the moon has been shown conclusively by the results of seven eclipse expeditions sent out by the department since 1905.

Considerable advance has been made in the study of the nature of magnetism and electricity and atomic structure. It has been found that certain bodies become magnetic due to rotation and conversely that rotation may be caused by magnetization. These facts have been confirmed by extensive experiments made in the department's experimental laboratories at Washington.

During the past few years more attention has been paid to a study of the structure of the atoms and in devising methods and instruments for detailed experiments. To produce high-speed electrical particles, available voltages of 5,200,000 volts have been obtained and methods for handling and applying this power are being perfected.

Laboratory experiments also have proved the existence of the Kennelly-Heaviside radio reflecting layer and its height and variations have been determined.

In atmospheric electricity, a study of the ocean results shows that the daily variation in the earth's electric charge, the so-called potential-gradient, is a function of universal time and not of local or sun time. A similar variation occurs in the theoretical current induced by the action of the rotating magnetic field of the earth on charged particles coming into the earth's atmosphere from the sun.

These facts shed new light on some of the fundamental problems of cosmical physics.

More concretely, magnetic charts issued periodically by the various governments for the use of navigators have shown marked improvement. Twenty-five years ago, errors as great as 3, 5, 10 and even 16 degrees occurred in the declination charts; 8 to 10 degrees in dip and 10 per cent. in horizontal intensity. The charts recently issued are rarely in error more than 1 degree.

An international magnetic standard has been determined and adopted. Our standard instruments have been compared with those of practically every observatory in the world, so that now all observations may be reduced to the same standard and used in any general analysis or discussion without any uncertainty.

This leads to probably the most important factor in the department's contribution—the advance in instrumentation. Research in the physical sciences can go forward only as rapidly as new methods and instruments are designed. This has been particularly the case with this department. New design and new instruments have been the cause of progress. The man chiefly responsible for this advance is now our assistant director, Mr. J. A. Fleming. The ocean work called, and is still calling, for new designs to allow for improved results and for expanded program. Land work and our new observatories have had similar histories. Especially is this true for atmospheric-electric and earth-current equipment. At no other observatory in the world is the equipment in these two branches so complete.

Some of these new instruments have been adopted by other countries and the department's influence has been felt in many ways, leading to improvements in methods and results, extension of surveys, increase in numbers of observatories and expansion of observatory programs. Among the factors exerting this influence may be mentioned the quarterly journal, *Terrestrial Magnetism and Atmospheric Electricity*, the prompt publication of results, the generous support of expeditions with loaned equipment and training of observers, the personal contact through observatory intercomparison and through visits of interested scientists to our laboratory in Washington and through the visits of the *Galilee* and *Carnegie* to many parts of the world.

J. P. AULT

Address by Dr. Adams

The return of the *Carnegie* from distant seas with all the store of information which it has collected can not fail to stir the imagination deeply. It has brought

us knowledge of the electric and magnetic currents of the earth, so vital to the mariner's compass, of life in the great depths of the sea, of the constitution of the ocean-floor, and of the mysterious winds of radiation which sweep the face of the waters from the depths of space. And yet this ship and the work of the men who have labored in it represent but one phase of the activities of the Carnegie Institution of Washington in promoting and extending the growth of knowledge. During the twenty-five years of the life of this great research organization there have been few branches of scientific thought to which it has not made notable contributions: and were one to attempt to define the field of its activity this could hardly be stated in terms less broad than as the history and development of life in all its forms, its relationship to its environment, and the nature of the physical world within which it exists.

One of the well-known younger writers of England in a skilful analysis of some of the aspects of modern life has stated that the progress of civilization is due to those who do the unnecessary work of the world. The author, the artist, the musician and the scientist are not contributing directly to the satisfaction of the material wants of men, and it is in this sense that Aldous Huxley uses the term "necessary." But if the word is extended to include what is vital and needful to the mind and spirit of men, the craving for beauty and for knowledge so deeply implanted within us, the unnecessary work of the world in a material sense becomes its most precious heritage and the distinguishing factor in the progress of the race. The dark ages of mankind are recognized, not as the periods of decline in material comfort, but as those within which the creative faculties are temporarily eclipsed, and the light of learning and discovery is dimmed. It is probable that the conditions of living in Europe about the year 1000 A. D. were superior to those in ancient Greece, but as between the contributions of the two periods to the culture and intellectual life of the world no comparison is possible.

The space of twenty-five years covering the life of the Carnegie Institution has seen by far the most extraordinary development of the physical sciences for any comparable period in history. It has been a time of remarkable discoveries, but, even more important, it has been a time of synthesizing of results, of establishing general principles and rules, and of placing facts in their proper relationship to one another and to the fundamental laws of nature. The last quarter of the nineteenth century might be characterized as a period in which isolated facts were observed and collected: the first quarter of the twentieth century as one in which these facts and many others were explained on the basis of broad and far-reaching generalizations. Between the relative values to the progress of science of these two types of contribution there can be little comparison; and it is the immense importance to research of new methods and new principles which makes the work of the bold but judicious imagination so essential a factor in the development of knowledge.

As an illustration of the value to science of a powerful and well-grounded theory, I should like to refer briefly to one taken necessarily from the field with which I am most familiar. If a metal like iron is melted and then vaporized in a furnace of very high temperature, and the light of the glowing gas is analyzed it is found to consist of a great number of lines characteristic of this metal, and this metal alone. Hydrogen has its own set of lines, carbon another, and so for all of the ninety elements known to the chemist. These lines are found in the light of the sun, the stars and even the immensely distant nebulae; and just as the chemist uses their presence in the analysis of materials in his laboratory, so the astronomer uses them to analyze the composition of the farthest stars.

The amount of observational labor devoted to the study of the spectral lines has been enormous. Their positions, their intensities, the nature of their variations and many other data have been catalogued, all in the realization that locked up in these lines is a wealth of information concerning the constitution of the atom and of matter which could lead to applications of the most far-reaching character. The key to the problem was provided by the theory of the atom developed by the great Danish physicist Bohr. This led at once to the first rational explanation of the mechanism by which an atom gives out light and radiation, and opened the way to the interpretation of essentially all that had previously remained unknown. Developments and applications have followed one another with amazing rapidity, the great mass of accumulated observations has been brought into a consistent and logical order, and the range of our physical knowledge has been steadily widened until it stretches from atom to sun, from sun to star, from star to universe. By its aid we can measure the life of a radiating atom in a star at the limits of our universe in billionths of a second of time, and the temperature in the interior of our sun in tens of millions of degrees.

A second marked characteristic of recent developments in science has been the realization of the intimate relationship, we may even say interpenetration, of its various branches. No department of physical science is sufficient unto itself. Biology and astronomy lean heavily upon physics and chemistry; physics depends more and more upon mathematics;

and, as the methods of statistical mechanics become more widely applied, the greater becomes the need for adequate check and control through the facts of observation. An excellent illustration is afforded by one of the important discoveries of recent years, that the molecule of oxygen, the basis of the whole system of the atomic weights of the elements, exists in two forms instead of the single form universally assumed. The discovery belongs to the field of chemistry; but the practical evidence was afforded by astronomical observations at Mount Wilson; and its interpretation is due to the theoretical physicists of the University of California working through intricate mathematical processes. I think it may justly be said that the Carnegie Institution has been a leader in the realization of this close interdependence of the various fields of science, and of the power for research of groups of coordinated investigators. Many of us will see tomorrow at Stanford University the dedication of a new laboratory in which will center the studies of men of wide diversity of training who are joining in a common effort to solve many of the great problems of the life and growth of plants and their adaptation to environment.

A very interesting development in modern science has been the remarkable boldness in the use of hypothesis, and the success which in nearly every case has attended it. A period which has produced the theory of relativity with its profound implications in science and philosophy, and has solved the age-old problem of the source of energy in the universe through the well-established theory of the conversion of matter into radiation, is certain to rank high in any history of the triumphs of the human mind. Although a speculative hypothesis of itself is often futile, that which is founded upon the facts of observation, and is developed to keep pace with them, becomes frequently the most powerful weapon of research within the capacity of science to use. It is this application of the highly trained imagination to the facts of nature which has made so extraordinarily productive the years within which we are living.

In any summary of the contribution of physical science to society chief stress is often laid upon the fundamental nature of the relationship of pure science to all inventions and processes which tend to increase the comfort and the productivity of men, and their ability to control and direct the forces of nature. The familiar example of the growth of the entire electrical industry of the world out of the scientific researches of Faraday is only one of innumerable instances. But the intangible effects of science are in many respects more interesting. Of its function in satisfying one of the deepest interests of life, the joy of discovery and the love of knowledge, I have already spoken. In its influence upon the judgment of men, their reasoning powers and the skilful weighing of evidence, its value is extraordinarily great. But perhaps beyond all else is the kindling and stimulation of the imagination. The child clothes with his imagery the simple things of nature; the intelligent man finds the phenomena of nature wonderful beyond all conception, and in the reaction to them of the powers of his imagination he finds one of the most enduring values of life.

Of the many and varied contributions of the Carnegie Institution to physical science it is impossible to speak in detail. They form an integral and vital part of the history of knowledge. Its investigators have studied deeply into the mysteries of life and the development and modification of species; they have searched into the complex processes by which the animal and vegetable life of the earth derives its growth and energy; they have added greatly to our knowledge of the past history of life upon the earth, and have welded links in its unbroken chain; they have studied the powerful forces within the earth, and have charted the magnetic field about it; they have numbered the stars and pushed far back the frontiers of the universe; they have penetrated deeply into the mysteries of matter and the world of space and time. Extending through all of these and many other investigations has been the realization of the unity of science and of the essential part it plays in the life of the race. On this anniversary of the establishment of the Carnegie Institution it may justly be said to have fulfilled amply the hopes of its founder in carrying the torch of learning and spreading its light among men.

WALTER S. ADAMS

OBITUARY

RECENT DEATHS

DR. MORTON PRINCE, professor of neurology at Tufts College and later associate professor of abnormal and dynamic psychology at Harvard University, died on August 31 in his sixty-fifth year.

DEAN FREDERICK FRANKLIN MOON, head of the New York State College of Forestry for nine years, died following an operation on September 3 at the age of forty-nine years. Mr. Franklin D. Roosevelt, governor of New York State, wrote as follows: "The sudden death of Franklin Moon, dean of the State College of Forestry, comes to me as a great shock. I saw him not long ago and he seemed to be in fine health and spirits and very much interested in the program of reforestation for the State of New York. Under Dean Moon the State College of Forestry at

Syracuse has become one of the most important institutions of its kind in America. The effect of the college instruction under his supervision has been felt through its graduates not only in this State but in every part of the country which is actively engaged in the rebuilding of our depleted forests. The State has suffered a great loss in the passing of Dean Moon in the prime of his usefulness."

THE deaths are announced of Dr. Louis Lejeune, professor of radiology and electrotherapy at Liége, and of Dr. Georg Kassner, professor of pharmaceutical chemistry at Münster.

MEMORIALS

A MEMORIAL service in memory of the life and work of the late Henry C. Wallace, Secretary of Agriculture in the Cabinets of Presidents Harding and Coolidge, will be held at Iowa State College, Ames, on October 18, as one of the features of the twelfth annual conference of the American Country Life Association. The memorial program will include the dedication of a group of trees on the campus and the placing of a stone among the trees bearing a plate stating briefly some of the main features of the service rendered to agriculture by Mr. Wallace.

The British Medical Journal writes that Drs. Fernand Bezançon, André Lemierre, Pierre Abrami, Marcel Brulé, Edouard Joltrain and Louis Pasteur Vallery-Radot have addressed a letter to Sir Almroth Wright inviting his cooperation in a memorial to Professor Fernand Widal, who died on January 14. The letter announced the setting up of a committee for the purpose of placing medallion portraits of Professor Widal in the Paris Faculty of Medicine and the Hôpital Cochin, and of publishing a collected edition of his works, a number of his colleagues in other countries having stated their desire to associate themselves with this project.

UPON request of Commander Richard E. Byrd, sent by radio through the New York *Times*, the National Geographic Society has forwarded the following message to Peter Scott, son of the English explorer, Captain R. F. Scott: "We hoisted the American flag here upon the return of the sun to Antarctica and in honor of your father and his comrades we unfurled the British flag alongside the American. All members of this expedition join me in best of good wishes to you and your family."

THE Italian government has caused a gold medal to be struck in memory of Finn Malmgren, and has also granted his mother a yearly pension of 2,000 Swedish crowns. Documents collected by the investigation committee on the *Italia's* castastrophe, which concerned the explorer, have been sent to his mother.

SCIENTIFIC EVENTS

THE KING PRIZES OF THE PEKING SOCIETY OF NATURAL HISTORY

THE King junior prize, consisting of a bronze medal and the sum of $20 local currency, is founded by Mr. Sohtsu G. King in memory of his brother, Mr. Kung-pao King, a charter member and former councilor of the Peking Society of Natural History. This prize will be awarded for the best collection of Chinese natural history objects with description notes made by any one under twenty years of age. The award shall be made annually by a committee of the society under the following conditions:

1. The prize shall be awarded for the best collection of plants or animals made by any one under twenty years of age.

2. The prize committee of the society shall adjudicate on the merit of the collections and notes.

3. It shall be within the powers of the committee: i. To define from year to year the character of the collection eligible for the prize; ii. To substitute or accept a description of the behavior or mode of life of particular plants or animals in place of a collection; iii. To make such alterations to these conditions as they may deem necessary in order to further the object of the founder, namely, the promotion of the observation of natural phenomena among young people in China.

4. The committee shall advertise these regulations and any amendments which they may make at least six months prior to the award of the prize. They shall also indicate the last date for the reception of collections or papers submitted for the prize.

The King senior medal, consisting of a gold medal, is founded by Mr. Sohtsu G. King in memory of his parents, Mr. and Mrs. Sung-yuan Daw King, with the object of encouraging original investigations in the field of natural history, in which subject his parents took the greatest interest. The medal is to be awarded annually, under the following conditions, for the most meritorious work on the flora or fauna of China:

1. The work shall be selected by a prize committee appointed by the executive council of the Peking Society of Natural History, who shall adjudicate its merits upon the basis of originality and its significances in the furtherance of knowledge concerning the flora or fauna of China.

2. Preference will be given to papers appearing in the society's publications, but the prize committee is at

liberty to select any paper on the subject of the natural history of China published either in China or abroad for the purpose of this award.

3. The prize may be withheld should the prize committee deem that no work published during the year is worthy of award.

THE BEIT MEMORIAL FELLOWSHIPS

A MEETING of the trustees of the Beit Memorial Fellowships for Medical Research was held recently for the election of fellows and other business. The annual report of the honorable secretary, Sir James K. Fowler, was presented. It stated:

The death of Lord Haldane, F.R.S., has deprived the trust of one by whose wise advice and unfailing interest it has profited since its foundation in 1909. In spite of indications which he himself recognized, he presided at a meeting of the trustees very shortly before his death "as he did not wish to be absent." The appointment of Lord Rayleigh, F.R.S., to fill the vacancy thus caused will be recognized as specially suitable.

The reports of the directors of laboratories on the work of the fellows are uniformly favorable, and all without exception dwell upon the energy with which the various problems presented by their researches are being attacked.

The year has been marked by an unusual number of resignations. As in all cases this has been due to the appointment of the fellow to a scientific post of a permanent character, it is incidentally a tribute to the value which is attached to the tenure of a fellowship. Often, moreover, the research is continued, but it has ceased to have the first call upon the time of the worker. The researches are in possibly increasing proportion concerned with problems "in the scientific subjects related to medicine" and do not lend themselves to a review of a general character. Those, however, who have seen the very remarkable film by Dr. Canti illustrating the actual method by which normal and cancer tissues are built up will be interested to know that Miss Honor B. Fell, who was last year appointed to a senior fellowship, has been associated in this work at the Strangeways Research Hospital, Cambridge.

Dr. Hindle, whose discovery of a vaccine protective against yellow fever was mentioned in last year's report, has experienced one of those setbacks which almost invariably attend work of such a character by the diminution in virulence of the strain of the virus with which he has been working. Such variations in virulence are well known in other virus diseases—*e.g.*, dogs' distemper—and therefore it is not surprising that similar changes should have occurred in the yellow-fever virus. The practical consequences are increased difficulties in testing the protective value of the vaccine, as it is necessary to use large numbers of monkeys. Efforts are now being made to reestablish the virulence of this strain and also to obtain other strains. Further evidence has been obtained which establishes the fact that those engaged upon this research, if unprotected, are subject to serious risk of infection.

The advisory board are of opinion that the records of the candidates at this election indicate a standard both as regards academic distinctions and subsequent performance at least as high as in any previous year.

Possibly in the next annual report advantage may be taken of the fact that twenty-one years will then have elapsed since the foundation of the trust to review the service which the work of the fellows has rendered to the advancement of medical science, although the intervention of the war period, during which all the fellows resigned to undertake work of more immediate service to the state, will prevent it from being a review of a similar number of years.

WESTERN FOREST FIRES

THE critical forest fire situation in the Western National Forests is somewhat improved but still far from satisfactory, according to reports received in Washington by the Forest Service, U. S. Department of Agriculture. In northern Idaho, where raging forest fires were rapidly approaching disastrous proportions a short time ago, cool weather with some rain has given some temporary relief. In spite of this change, 4,900 fire fighters are rushing work to make the many large fires safe from further outbreak in anticipation of the possible recurrence of dry weather. In Washington and Oregon, where several large uncontrolled fires are being fought by hundreds of men, the weather remains hot and dry with no relief predicted. In California the weather has become more favorable to the work of fire control and no large fires are now burning.

More than $1,000,000 has been spent by the Forest Service in the last three weeks in fighting forest fires, and in the fire season more than 500,000 acres have been burned over in the Western National Forests. In the six Western National Forest Districts, comprising the Rocky Mountain and Pacific Coast region, there have been in that period 5,025 separate fires, 3,016 of which have been caused by lightning and 2,009 by human agency.

"Lightning fires have been unusually troublesome this year," says E. A. Sherman, acting chief of the Forest Service in the absence of Major R. Y. Stuart, who is in the west studying national forest needs with the agricultural subcommittee of the appropriations committee of the House of Representatives. "Fires caused by human carelessness are unnecessary and will be eliminated by education and law enforcement. Bunched lightning fires, sometimes running to 300 or 400 separate fires set by one dry electrical storm, will always present the risk of disaster unless adequate means are provided to cope with them. This means especially a complete system of roads and trails throughout the National Forests, including especially the now almost inaccessible country where lightning strikes most frequently. It means, secondly, an avail-

able trained force of fire guards sufficient to strike immediately the maximum number of fires set by any electrical storm. Only by such means will it be possible for the government to avoid the recurrence of such destructive and costly disasters as we have had this year. The Federal Forest Protection Board, composed of representatives of all federal agencies concerned in the problem of forest protection, shares the forest service view-point on the forest fire situation."

THE NEW BUILDING OF THE U. S. DEPARTMENT OF AGRICULTURE

THE central structure of the Department of Agriculture building, the first unit of the present federal building program in Washington, D. C., is nearing completion with some prospects of it being ready for occupancy shortly after January 1, according to an oral statement made to the *U. S. Daily* by the chief clerk and superintendent of buildings of the department, Mr. R. M. Reese. The building, now under construction at an estimated cost of $2,000,000, was planned twenty years ago.

Mr. Reese explained that the builders are under contract stipulation to have the structure ready by April 1, 1930.

The building will house the offices of the Secretary of Agriculture, the Assistant Secretary of Agriculture, five directors, the solicitor, the chief clerk and other administrative officers. The height of the building, which is of Georgia marble, is five stories and basement. The authorized appropriation is $2,000,000. Its architects are Rankin and Kellogg, of Philadelphia, who also were the architects for the east and west wings.

The construction of the new building began twenty years from the time the department began occupancy of the east and west wings. The new building is fronted by twelve Corinthian columns and has a large interior court, glassed over at the level of the second floor. The interior court will contain a fountain and the Department of Agriculture war memorial, which is now in course of sculpture, for installation when the building is completed.

The inscriptions carved on the front of the building are: (1) "The husbandman that laboreth must be first partaker of the fruits."—St. Paul. (2) "No other human occupation opens so wide a field for the profitable and agreeable combination of labor with cultivated thought as Agriculture."—Lincoln. (3) "With reference either to individual or national welfare, Agriculture is of primary importance."—Washington.

The completed building—that is, all three units, the old east and west wings and the new central structure —will have an entire frontage of 750 feet.

The Department of Agriculture now occupies in Washington more than forty buildings of various types. Some of these are the property of the federal government and some of them are rented from private enterprise.

OFFICIAL AMERICAN DELEGATES TO THE INTERNATIONAL ENGINEERING CONGRESS IN TOKIO

THE official list of delegates chosen by the scientific and technical societies and engineering educational institutions of this country to represent them at the coming World Engineering Congress in Tokio has been issued by Maurice Holland, executive secretary of the American committee of the congress and director of the division of engineering and industrial research of the National Research Council. The number of official delegates to the congress allocated to the United States by the Japanese authorities was set at about sixty, though the number of Americans to participate will be about 250.

The four "founder" societies, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society of Civil Engineers, as well as the American Association for the Advancement of Science and national organizations of the special lines of engineering, designated the official American representatives who cover practically the whole range of engineering and technology in the United States. The party will sail for Tokio on October 10 from San Francisco. Two ships, the *President Jackson* and the *Korea Maru,* have been chartered.

At a recent meeting of the committee the designating of official delegates was closed with the appointment of the following:

Magnus W. Alexander, A. S. M. E., president of the National Industrial Conference Board, New York; Dr. H. Foster Bain, secretary of the A. I. M. M. E., New York; Dr. George D. Barron, vice-president of the A. I. M. M. E., Rye, N. Y.; Edward Bartow, professor of chemical engineering, State University of Iowa; F. W. Bradley, president of the A. I. M. M. E., San Francisco; Dr. George K. Burgess, director of the Bureau of Standards, Washington; Howard E. Coffin, the Society of Automotive Engineers, Detroit; W. H. Carrier, the American Society of Refrigerating Engineers, Newark; George S. Davison, former president of the A. S. C. E., Pittsburgh; John V. N. Dorr, the Engineering Foundation, Pittsburgh; Byron E. Eldred, New York; William Elmer, vice-president of the A. S. M. E., Philadelphia; John R. Freeman, Providence, R. I.; E. H. Fritch, secretary of the American Railway Engineering Association, of Chicago; George W. Fuller, American Society of Civil Engineers, New York; Mrs. L. M. Gilbreth, Montclair, N. J.; C. E.

Grunsky, past president of the A. S. C. E., San Francisco; F. C. Hanker, Pittsburgh; Allen Hazen, A. S. C. E., New York; H. D. Hibbard, A. I. M. M. E., Plainfield, N. J.; Maurice Holland, National Research Council, New York; John C. Hoyt, A. S. C. E., Washington; F. L. Hutchinson, national secretary, A. I. E. E., New York; James E. Ives, U. S. Public Health Service, Washington; D. C. Jackson, Massachusetts Institute of Technology, Boston; F. B. Jewett, New York; Major-General Edgar Jadwin, former Chief of Engineers, War Department, Washington; C. M. Keys, Garden City; C. W. Latimer, New York; C. K. Leith, professor of geology, University of Wisconsin; Wilfred Lewis, Haverford, Pa.; Paul M. Lincoln, director, School of Electrical Engineering, Cornell University; Francis F. Lucas, New York; Charles T. Main, president of the American Institute of Consulting Engineers, Boston; R. R. Martel, associate professor of civil engineering, California Institute of Technology, Pasadena, Calif.; F. O. Martin, South Pasadena, Calif.; Charles D. Marx, professor emeritus of civil engineering, Leland Stanford University; William Benson Mayo, Detroit; C. W. Merrill, A. I. M. M. E., San Francisco; O. C. Merrill, chairman of the American committee, World Power Conference, Washington; Ralph Modjeski, New York and Philadelphia; L. A. Osborne, New York; H. de B. Parsons, American Institute of Consulting Engineers, New York; Asa E. Phillips, American Society of Municipal Improvements, Washington; Donald B. Prentice, dean, Lafayette College, Easton, Pa.; Antonin Raymond, architect for the United States Embassy, Tokio; Henry G. Reist, Schenectady, N. Y.; Mark L. Requa, San Francisco; J. V. W. Reynders, vice-president of the A. I. M. M. E., New York; Calvin W. Rice, secretary of the A. S. M. E., New York; Robert H. Richards, professor of mining engineering, M. I. T., Boston; Joseph W. Roe, professor of engineering, N. Y. U.; David Rushmore, A. S. M. E., New York; Herman Schneider, president, University of Cincinnati; R. F. Schuchardt, Chicago; C. E. Skinner, Pittsburgh; George Otis Smith, director, Geological Survey, U. S. Department of the Interior; Elmer A. Sperry, president of the A. S. M. E. and chairman of the American committee of the World Engineering Congress, Brooklyn; Charles W. Stone, Schenectady; Francis Lee Stuart, Engineering Foundation, New York; A. N. Talbot, past president of the A. S. C. E.; Max Toltz, A. S. M. E., St. Paul; E. N. Trump, A. S. M. E., Syracuse; Daniel L. Turner, New York; H. Bruce Walker, professor of agricultural engineering, University of California; William Y. Westervelt, American Electrochemical Society, New York.

SCIENTIFIC NOTES AND NEWS

THE Ninth International Congress of Psychology meeting last week at Yale University selected Copenhagen as the place of meeting in 1932, with Professor Harold Höffding as president. The registered attendance at New Haven was 1,051, including 129 from 22 foreign countries and 722 members of the American Psychological Association. Accounts of the proceedings of the congress and of the International Physiological Congress held at Harvard University will be printed in SCIENCE.

THE American Chemical Society is meeting this week in Minneapolis under the presidency of Dr. Irving Langmuir, director of research of the General Electric Company. According to the program there are 20 general and sectional meetings at which 325 papers are being presented.

AT the closing session of the annual meeting of the American Astronomical Society at Ottawa Dr. Robert Aitken, of the Lick Observatory, was elected a vice-president, and V. M. Slipher, of Flagstaff, Arizona, was reelected. Dr. R. S. Dugan, Princeton University, secretary, and Dr. Benjamin Boss, Albany, N. Y., treasurer, were reelected. Professor Ernest W. Brown, of Yale University, has still two years to serve as president. The meeting for 1930 will be held at Harvard University.

AT the triennial meeting of the International Congress of Surgery held in Warsaw last July a new class of members—honorary members—was created and Dr. W. W. Keen, of Philadelphia, was elected as the first honorary member. The next meeting of the congress will be held in Spain in 1932.

IN recognition of his long service as president of the Medical College of Virginia, Richmond, from which Dr. Stuart McGuire retired on July 1, 1925, the board of visitors of the college has established the McGuire Lectureship, which will be filled annually by an invited speaker. The subjects of the lectures will usually cover topics related to medicine, dentistry, pharmacy or nursing, the fields covered by the several schools of the institution.

Nature calls attention to the eighty-fifth birthday on August 25 of Sir Thomas Muir, the mathematician, who has been resident for upwards of forty years in Cape Colony. In 1892 he was appointed superintendent-general of education in Cape Colony, holding office until 1915, when he received the honor of knighthood in recognition of work in new fields of educational effort. Sir Thomas Muir is the author of papers contributed to the Royal Society of Edinburgh, the *Messenger of Mathematics* and the *Philosophical Magazine*, as well as to the publications of the South African Philosophical Society. He was an active promoter of the program of the British Association on its first visit to South Africa in 1905. In 1910, he was president of the Cape Town meeting of the South African Association, and delivered an ad-

dress on "The State's Duty to Science." The Royal Society of Edinburgh has on three occasions awarded to him the Keith gold medal for researches into the theory of determinants and allied subjects.

DR. LEWELLYS F. BARKER, of Baltimore, will be the first incumbent of the newly established visiting professorship in the medical school of the University of California. Dr. Barker is expected to arrive in California in March for a month of lectures and clinics which will be open not only to students but also to all members of the medical profession.

DR. ALFRED LANDE, of the University of Tübingen, professor of theoretical physics, has been appointed visiting member of the faculty at the Ohio State University for the autumn and winter quarters, and Dr. L. H. Thomas, Trinity College, University of Cambridge, has been appointed visiting assistant professor of theoretical physics for the autumn, winter and spring quarters.

DR. H. J. WEBBER, professor of subtropical horticulture and director of the Citrus Experiment Station of the University of California, has retired from the directorship. Dr. Webber will devote his time to research on citrus stocks. He has been succeeded by Dr. L. D. Batchelor.

DR. JOHN LEE COULTER, president of the North Dakota College and Station, has been appointed chief economist of the U. S. Tariff Commission.

LIEUTENANT-COLONEL M. TYLER, of the Army Engineering Corps, has been appointed chief engineer of the Federal Power Commission.

RALPH T. K. CORNWELL has resigned as assistant professor of organic chemistry at the University of Pittsburgh to accept an appointment as senior microanalyst at the Hygienic Laboratory of the U. S. Public Health Service, Washington, D. C.

DR. M. K. BUCKLEY, assistant professor of chemistry in the University of Buffalo, has become a member of the staff of Barton A. Bean, Jr., and associates, patent and trade mark counsel, Buffalo, N. Y., as chemical technical adviser.

LELAND B. SNODDY, of Lexington, Ky., has been granted an Edison Fellowship for Research in the Research Laboratory of the General Electric Company at Schenectady, N. Y., for the year 1929–30. This fellowship was established by the General Electric Company this year in honor of Thomas A. Edison and in commemoration of the fiftieth anniversary of his incandescent lamp. It carries a grant of $3,000, and its purpose is to give the fellow an opportunity to carry on research work of his own choice, provided suitable laboratory facilities are available. Mr. Snoddy was selected by a committee composed of Dr. George K. Burgess, director of the U. S. Bureau of Standards and chairman of the National Research Council, chairman of the committee; Dayton C. Miller, professor of physics of the Case School of Applied Science, and James E. Mills, chief of the research division of Edgewood Arsenal.

PROFESSOR W. D. MATTHEW, chairman of the department of paleontology at the University of California, has returned to Berkeley after spending the summer at the American Museum of Natural History in New York, where he has been working on a report of the critical period in the development of mammals which occurred during the early Tertiary.

DR. ALAN M. BATEMAN, professor of economic geology at Yale University, who has been in attendance at the International Congress of Geology at Cape Town, South Africa, spent a month in the copper districts.

THE U. S. Public Health Service reported to the *U. S. Daily* on August 31 that a fifth laboratory worker, Surgeon W. T. Harrison, has been stricken with undulant or "Malta" fever, while pursuing scientific investigation on this malady. Dr. Harrison, it was stated, was stricken about six months ago, but is improving. Just before he was stricken, Surgeon Edward Francis contracted undulant fever. The first laboratory case occurred in 1920, when Miss Alice C. Evans, bacteriologist, became ill. Shortly after Miss Evans's attack, B. T. Sockrider, laboratory assistant, was stricken, then Surgeon G. C. Lake, who was followed by Dr. Francis and Dr. Harrison.

THE foreign members of the Thirteenth International Physiological Congress visited Cold Spring Harbor on August 27, arriving by motor bus. Exhibits were shown at the department of genetics, Carnegie Institution of Washington, by Dr. Oscar Riddle, who demonstrated "thyroid" and "pituitary" races of pigeons, as a part of results accomplished in the physiological standardization of animals; also sex-reversal from wide crosses, and three hereditary diseases—ataxia, hemophilia, myoclonus—common to man and pigeon; by E. C. MacDowell, who exhibited his findings on the growth of mice under maximal conditions and on leukemia in mice; by Dr. A. M. Banta on sex control in Daphnids by cold and various chemical agencies; by Dr. H. H. Laughlin on the measurement of racing ability in the thoroughbred horse and on the measurement of inheritance in racing; by Dr. A. F. Blakeslee on variations in Datura, due to extra chromosomes; by Dr. J. T. Buchholz on physiology of pollen-tube growth; by Miss S. Satina on biochemical differences between male and female mucors and other plants. Dr. C. W. Metz exhibited a cinematograph picture of chromosome behavior in a

maturation division of Sciara, and Dr. C. B. Davenport methods of human genetical study. At the Biological Laboratory of the Long Island Biological Association a demonstration was given of physiological researches. The visiting physiologists were guests of Dr. and Mrs. Graham Lusk at luncheon and visited the Tiffany House and Foundation.

THE president of the American Chemical Society, Dr. Irving Langmuir, will make a lecture tour in the mid-west, following the termination of the meeting of the society at Minneapolis. The title of his lecture will be, "Chemical Reactions Produced by Heating Tungsten or Platinum Filaments in Gases," and he will speak before the following sections which will hold joint meetings for that purpose: Monday, September 16—Milwaukee, a joint meeting of the Wisconsin and University of Wisconsin sections; Tuesday, Davenport, Iowa, a joint meeting of the Illinois-Iowa and University of Iowa sections; Wednesday—Omaha, Nebraska, a joint meeting of the Nebraska and University of Nebraska sections; Thursday—Kansas City, a joint meeting of Kansas City, University of Kansas and Wichita sections; Friday—Columbia, Missouri, a joint meeting of the Missouri, Rolla and University of Missouri sections. These sections of the American Chemical Society are meeting to do honor to their president and at the same time taking advantage of the meeting to discuss matters of mutual cooperation such as coordinations of programs, etc. Dr. Langmuir will make another tour of the local sections of the American Chemical Society in the eastern Atlantic states in October. These tours are under direction of the Local Section Officers' Committee.

THE American Physiological Society held its forty-first annual business meeting on August 19 at the Harvard Medical School. The usual scientific program was merged with that of the thirteenth International Physiological Congress. The following new members were elected to the society: Wm. F. Allen, Philip Bard, Anna M. Baetjer, Walter Bauer, E. A. Boyden, K. K. Chen, Otis M. Cope, Joseph A. Dye, George S. Eadie, M. H. Friedman, H. K. Hartline, Joseph C. Hinsey, Edmund Jacobson, Edward Larson, Jacob Markowitz, F. D. McCrea, B. McGlone, Elizabeth Marsh, Heinrich Necheles, Paul Roth, Carl F. Schmidt, Isaac Starr, Jr., Eugene U. Still, Maurice L. Tainter, Edward Lee Travis, J. P. Quigley. The officers elected for the year 1929–30 are as follows: *President,* Walter J. Meek, University of Wisconsin; *Secretary,* A. C. Redfield, Harvard University; *Treasurer,* Alexander Forbes, Harvard University; *Councilor* for 1929–33, John M. Murlin, University of Rochester.

A COMMITTEE of physicians, appointed by President John A. Hartwell and Director Linsly R. Williams, of the New York Academy of Medicine, at the request of B. M. Baruch, chairman of the Saratoga Springs Commission of the State of New York, has completed a study of the principal spas of France, Germany and England. Their report will be incorporated in the recommendations the Saratoga Springs Commission will make to the next legislature. The committee embraced Dr. Malcolm Goodridge, professor of clinical medicine, Cornell University Medical School; Dr. John Wyckoff, professor of medicine, New York University Medical School; Dr. L. Whittington Gorham, of the Albany Medical College of Union University; Dr. E. H. L. Corwin, executive secretary of the public health committee of the Academy of Medicine, and Dr. Milton B. Rosenbluth. The committee devoted the month of August to its studies. The Saratoga Springs Commission will propose a plan for the final development of the state plant at Saratoga Springs, in which a capital investment of $5,000,000 has already been made.

MEMBERS of the International Water Committee of the United States and Mexico recently held a meeting in Mexico City. The waters in controversy between the two nations, and the rights to which the committee will attempt to adjudicate, are the lower Rio Grande, the Colorado and the Tia Juana. American members of the committee include Frank Adams, professor of irrigation investigations and practices in the University of California, and Dr. Elwood Mead, professor emeritus of rural institutions, of the university, now U. S. commissioner of reclamation; W. E. Anderson, San Antonio, Texas, and L. H. Beach, U. S. A., retired.

SECRETARY HYDE issued on August 21 a general revision of the Mediterranean fruit-fly quarantine and regulations, effective September 1, under which Florida fruits, vegetables, nursery stock and other restricted articles may be moved interstate during the coming shipping season. Under the revised regulations provision is made for the movement in interstate commerce of all restricted fruits and vegetables other than those produced in areas or on properties which may be determined as infested. All infested fruit is required to be promptly destroyed, but the destruction of host fruits and vegetables over considerable areas surrounding the infestation will be discontinued. This change of policy is made possible as a result both of the intensive eradication effort in Florida of the last four months and the determination of methods of sterilizing citrus and other host fruits which are believed to eliminate risk of carrying infestation. Such movement will be further safeguarded for the present

by control of distribution. With the development of adequate facilities for the commercial application of these methods of sterilization it is expected that a broader field than that now authorized will be open for the marketing of Florida host fruits and vegetables.

CONSTRUCTION began in August on the new McMillan Hospital and Oscar Johnson Institute of Ophthalmology and Otolaryngology at Washington University, Saint Louis. Dr. Harvey James Howard, professor of ophthalmology, was recently appointed executive director of the hospital and institute, which will cost, including equipment, about $1,300,000.

PLANS for the immediate construction of a seven-story building by the New York Polyclinic Medical School and Hospital for clinics and pathological laboratories are announced by Henry Staton, secretary of the board of trustees. The clinic building will adjoin the present main hospital on West Fiftieth Street and will cost nearly $1,000,000, including equipment.

Nature reports that the British National Radium Trust, which is constituted as follows: Lord Parmoor (*chairman*), Mr. Arthur Greenwood, Mr. W. Adamson, Sir Ernest Rutherford, Sir John Rose Bradford, Lord Moynihan, Lord Dawson, Lord Mackenzie, Professor A. H. Burgess and Viscount Lee, has made preliminary arrangements in connection with the purchase of radium, with the view of placing it as soon as practicable at the disposal of the expert body, the Radium Commission. The commission has now been set up in accordance with the provisions of the Royal Charter, and is composed as follows: Viscount Lee (*chairman*); Lieutenant-Colonel Smallman, Medical Officer of the Ministry of Health; Mr. H. L. F. Fraser, assistant secretary of the Department of Health for Scotland; Professor Sidney Russ, professor of physics, Middlesex Hospital Medical School; Dr. G. W. C. Kaye, superintendent of the physics department of the National Physical Laboratory; Dr. J. M. W. Morison, lecturer in radiology, University of Edinburgh; Professor G. E. Gask, professor of surgery, University of London; Mr. W. Ernest Miles, surgeon to the Cancer Hospital, Brompton; Dr. Comyns Berkeley, gynecological surgeon to the Middlesex Hospital; Dr. Carlton Oldfield, professor of gynecology, University of Leeds, and Professor A. J. Hall, professor of medicine, University of Sheffield.

AT the last session of the Academy of Colonial Sciences, Dr. Sorel, according to the Paris correspondent of the *Journal* of the American Medical Association, gave an account of the means employed to combat the recent epidemic of yellow fever at Dakar. The life history of Stegomyia being known, the whole crusade against the pest consisted in the destruction of the mosquito, its larvae and its ova. This necessitated the launching of a wide-spread hunting campaign throughout the haunts of the insect and its hatching grounds. This campaign was carried out with scientific precision and thoroughness, with as little inconvenience for the people as possible, so that all showed a willingness to aid in the undertaking. The figures given here reveal something of the magnitude of the operations. The mosquito brigade consisted, during the first period, of twenty-four crews of three mosquito destroyers each, and, during the second period, three new crews of ten mosquito destroyers each were added. All these crews were provided with modern equipment. For a year, 300 scouts were employed for the complete cleansing of the city. More than 60,000 cubic meters of rubbish was thrown into the sea. The total amount of disinfected buildings, from the palace of the government down to the humblest native hut, comprised a surface area of 1,400,000 cubic meters. This disinfection required the use of 18 tons of sulphur, 400 grenades of fuming sulphuric acid and 230 Kg of solution of formaldehyde, and entailed an expenditure of about 500,000 francs ($20,000). Not a single mosquito remained in Dakar. All that is needed is to make the present condition permanent.

The British Medical Journal reports that the council of the Canadian Medical Association has determined to establish a Blackader lectureship in diseases of children as a tangible expression of its appreciation of the services rendered by Dr. A. D. Blackader, who has resigned the editorship of the *Canadian Medical Association Journal*, and as a mark of recognition of his eighty-second birthday. It was agreed that $5,000 should be collected to endow the proposed lectureship, which will commemorate the pioneer and long-lasting interest taken by Dr. Blackader in the field of disease in childhood. The income of this capital will be applied once in every three years to provide an honorarium for the pediatrician chosen to deliver the lecture.

UNIVERSITY AND EDUCATIONAL NOTES

PRINCETON UNIVERSITY receives a bequest of $100,000 by the will of the late Percy Rivington Pyne, of Bernardsville, New Jersey. Mr. Pyne also leaves $25,000 to the New York Zoological Society.

THE legislature has authorized the regents of the University of California to sell the old campus and buildings at Los Angeles with the provision that from the proceeds $125,000 is to be used for the construction of a new wing to the main building at the Citrus Experiment Station, Riverside, and $150,000 for the construction of a building for subtropical horticulture on the new campus of the university at Los Angeles.

The total budget of the College of Agriculture for 1929–30, exclusive of the above items, is $2,394,871.32, an increase of about $155,000 over the present year. Among the special allotments provided is $25,000 for an insectary at the Citrus Experiment Station.

THE University of Alabama School of Medicine announces the following appointments of new teachers for the coming year: Professor and head of the department of anatomy, Dr. Edward A. Boyden, formerly assistant professor of anatomy at Harvard University and professor at the University of Illinois; instructor in histology and embryology, Dr. Thomas E. Hunt, of the University of Chicago; instructor in gross and applied anatomy, Franklin S. DuBois, of the University of Illinois; research associate in anatomy, Dr. Eleanor L. Abrams, of the University of Chicago; instructor in pathology and bacteriology, Allan W. Blair, of the Pathological Institute of the Royal Victoria Hospital, McGill University, Montreal.

DR. PERCY WELLS COBB, of the Nela Park Research Laboratory, Cleveland, Ohio, has accepted an appointment as associate professor of biophysics in the department of ophthalmology at Washington University, Saint Louis. Dr. Cobb is now in Europe attending the International Congress of Ophthalmology in Amsterdam, as is also Dr. Charles Weiss, associate professor of experimental bacteriology in the same department.

DR. FRANCIS BAYARD CARTER, assistant in medicine, Yale University School of Medicine, New Haven, has been appointed head of the department of obstetrics and gynecology at the University of Virginia with rank as associate professor.

DR. JOHN WENDELL BAILEY, head of the department of biology at Mississippi College, has accepted a similar position at the University of Richmond, Virginia. Robert F. Smart has been appointed assistant professor of botany.

AT the University of Cambridge, Mr. F. H. Garner has been appointed university lecturer in agriculture, and Dr. A. S. Watt has been appointed university lecturer (Gurney lecturer) in forestry, both for three years.

M. ROMAN has been appointed professor of geology in the University of Lyons to succeed the late M. Depéret.

DISCUSSION

THE ORIGIN OF CHLOROPHYLL AND ITS RELATIONSHIP TO THE BLOOD PIGMENTS

NOACK has published another interesting paper on the origin of chlorophyll.[1] It is known that the formation of chlorophyll takes place, in most cases, only in the light, while in leaves that are grown and extracted in the dark a chlorophyll-like substance, protochlorophyll,[2] may be obtained. This is present only in very small amounts and exhibits a red fluorescence similar to that of chlorophyll.

Noack has been investigating the formation of chlorophyll from protochlorophyll, which he has obtained pure enough for many experimental purposes. Acid splits off magnesium from protochlorophyll, the same as it does from chlorophyll, to form another pigment which he calls protopheophytin, in analogy to pheophytin. By the introduction of magnesium, protopheophytin can be reconverted into protochlorophyll. Protopheophytin has a beautiful red color and Noack was quite certain that this compound belonged to a class of pigments that were already known. Investigation showed it to be quite similar to the pigment that is found in small amounts in the galls of animals that have been fed on green fodder. This pigment has been called phylloerythrin or bilipurpurin. It has been prepared in crystalline form from the galls of cattle. Preliminary investigations showed this pigment and protopheophytin to have essentially the same chemical constitution, although phylloerythrin produces no ester and has its acid group present in the form of an anhydride. By exercising special care the free acid could be split off by the use of weak alkalies. This acid showed a typical blood porphyrin spectrum and could be transformed into other anhydrous compounds. These compounds were spectroscopically identical with the compounds that have been obtained from protopheophytin. Also, by introducing magnesium into the phylloerythrin a green substance was obtained which had a spectrum almost identical with that of protochlorophyll. Thus, the chlorophyll that is contained in green fodder, when introduced into the animal body, can be transformed into a pigment which conversely may be considered as the first step in the formation of chlorophyll of plants. Having established this fact Noack then endeavored to ascertain the manner in which this transformation takes place. He sought to do this by starting out with chlorophyll, a compound whose identity has been established chemically. By mild reduction in acid solution, he succeeded in converting pure

[1] Kurt Noack, *Forschungen und Fortschriftte*, 5: 100–101, 1929.

[2] See SCIENCE, 68: 569, 1928.

preparations of chlorophyll and its separate modifications, a and b, into protopheophytin, pheophytin being formed as an intermediate step. Subsequent removal of the ester groups gave the same free acid that had been obtained from the phylloerythrin of galls. This acid gave the same spectrum as blood porphyrin. Anhydro-compounds were also obtainable from the free acid and these were identical in spectra and other properties with those formed from natural protopheophytin and phylloerythrin.

The chemical relation of chlorophyll to protochlorophyll thus has been cleared up by establishing that chlorophyll is an oxidation product of protochlorophyll. In addition the gap between the leaf and blood pigments has been bridged.

In the green plant this means that the photo-oxidation of protochlorophyll is the final step in the formation of chlorophyll.

An explanation can also be made of the rôle which iron plays in the formation of the green pigments, since it is well known that absence of iron is a cause of the chlorosis of leaves and since Noack had previously shown that the fluorescent organic pigments, including chlorophyll, possess a strong photo-oxidative action which is decidedly hastened by the presence of small amounts of iron.

Furthermore, this shows a noteworthy relationship between the chemical activity involved in the formation of chlorophyll and the function of chlorophyll, since Noack had in an earlier paper shown that the photo-oxidative action of chlorophyll is linked up somehow with the assimilation of carbon dioxide. This indicates that in the physiology of animals the formation of phylloerythrin from chlorophyll involves a reduction process. In addition, the spectroscopic agreement of cleaved phylloerythrin with the blood porphyrins lends definite support to the often disputed formation of blood pigment from chlorophyll. Hans Fischer has already pointed out the importance of phylloerythrin as a product formed biologically from chlorophyll.

This paper by Noack shows very clearly a relation between the green pigment found in leaves and the red pigment found in blood. It does not show just how the blood pigment is formed from chlorophyll. The paper is concerned with two problems very important in biochemistry. The first problem concerns the origin of chlorophyll. Showing that chlorophyll comes from protochlorophyll does not solve the problem. It will be solved only when we know how protochlorophyll is produced.

The other problem concerns the manner in which blood pigment is produced from chlorophyll. Is the relation a direct one or is chlorophyll broken down and then resynthesized as blood? These two important problems must sooner or later be solved by biochemists, as they are most fundamental in all plant and animal life.

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SIGNIFICANCE OF POST-ILLINOIAN, PRE-IOWAN LOESS

IN the May 24, 1929, issue of SCIENCE, Mr. Frank Leverett questioned the writer's correlation of the Loveland loess of western Iowa with post-Illinoian, pre-Iowan loess on Illinoian till in western Illinois and southeastern Iowa. Leverett stated that the probable correlation of the Loveland loess of western Iowa is with pre-Illinoian loess rather than with post-Illinoian loess; he considers the Loveland loess to be pre-Illinoian, pre-Iowan in age and not post-Illinoian, pre-Iowan in age as the Loveland has been interpreted to be by the writer. Leverett and the writer agree that the Loveland loess of western Iowa is post-Kansan gumbotil erosion, pre-Iowan in age; we differ as to whether it is the loess which underlies the Illinoian till or the loess which overlies the Illinoian till that is of the same age as the Loveland of western Iowa. Since the Loveland loess of western Iowa was deposited within the interval of time during which both the pre-Illinoian and post-Illinoian loesses were laid down in the Illinoian drift area, it may well be that although the Loveland loess appears to be a single formation, in reality its lower part may be pre-Illinoian in age and only its upper part post-Illinoian in age; and it may be that a part of the Loveland of western Iowa was deposited during the Illinoian glacial stage.

The purpose of this brief paper is to make clear that the post-Illinoian loess which the writer correlated with the Loveland loess of western Iowa would lose none of its significance as evidence in establishing the relative ages of the Iowan and Illinoian tills even if further investigations were to demonstrate that all or a part of the Loveland loess of western Iowa is pre-Illinoian rather than post-Illinoian in age.

There are two loesses on the Illinoian till, only the younger of which, the Peorian loess, is also on the Iowan till. The older loess is by no means a "nondescript deposit" found only in "a few places" as stated by Leverett. It has been mapped widely by members of the Illinois and Iowa Geological Surveys.

On the Iowan till the Peorian loess only is present. This loess has been shown by Calvin, Alden and Leighton, the writer and others to be genetically related to the Iowan till and to have been deposited very soon after the retreat of the Iowan ice-sheet. There is beneath the Iowan till in places a loess which resembles the older loess on the Illinoian till

and which the writer believes is in whole or in part of the same age as the older loess on the Illinoian.

The older loess on the Illinoian is post-Illinoian, pre-Peorian loess in age. It was deposited after the development over wide areas, chiefly by chemical weathering, of gumbotil more than three feet thick on the Illinoian till. Furthermore, there was sufficient time after this loess was laid down for it to have been leached in places to a depth of several feet before the deposition of the Peorian loess which as stated is but little younger than the Iowan till. The interval between the time of deposition of the Illinoian till and the deposition of the Peorian loess was of sufficient duration to account for (*a*) the weathering of the unoxidized and unleached Illinoian till to gumbotil more than three feet thick; (*b*) the deposition of a loess on the gumbotil and eroded surfaces of Illinoian till, and (*c*) the leaching of this loess in places to a depth of several feet. In contrast, the Peorian loess was deposited very soon after the deposition of the Iowan till. These facts indicate clearly that the Iowan till is much younger than the Illinoian till.

Regardless of whether or not the post-Illinoian, pre-Peorian loess is Loveland in age it "adds new evidence to that which has been presented for many years by several geologists in support of the view that the Iowan glacial stage is much younger than the Illinoian glacial stage."

The writer discussed fully the relative ages of the Iowan and Illinoian drift sheets in a paper in *American Journal of Science*, December, 1928.

GEORGE F. KAY.

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PECULIARLY SHAPED HAILSTONES

ON Saturday afternoon, June 15, at about 3 o'clock, what may have been considered a typical semi-cloudless sky became suddenly overcast from the southwest followed by a slight shower of unusually large drops which soon were accompanied by occasional hailstones. The Weather Bureau's forecast was "increasing cloudiness." Within a few minutes the rain turned to hail. It was not a heavy hail-storm; no damage was done to the flowering shrubs in our garden—a few lily-pads were pierced—yet in a space about seventy-five feet square the lawn was strewn with the most grotesque-shaped hailstones that I ever had chanced to see. I picked up hurriedly four specimens, the largest of which I sketched from memory (Fig. 1). It was about 6.5 cm long, 2 cm thick and about 3.5 cm wide. The "stone" seemed to be made up of an agglomerate of a dozen or more smaller stones frozen together. The nucleus of the separate stones could readily be distinguished. The mass was flinty hard, as freshly frozen ice, and except for the nuclei was clear.

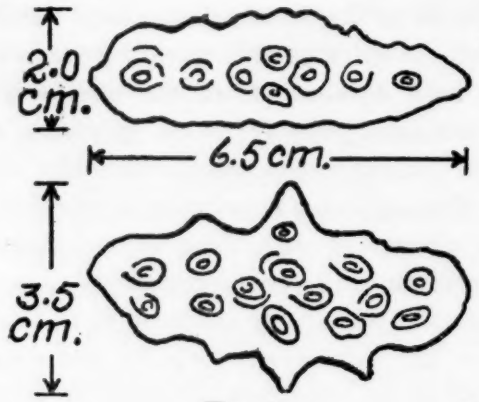

FIG. 1

The hail-storm was not characterized by large hailstones, the largest single-nuclear stone that came to my notice in the garden was but 1½ to 2 cm in diameter. I have witnessed many hail-storms of much greater severity and of longer duration, but never saw the stones frozen in agglomerates, especially of such size.

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MORTALITY STATISTICS AND THE LENGTH OF LIFE

PROFESSOR FORSYTH'S paper in SCIENCE, July 26, directly contradicts the prevalent opinion on the subject discussed. Mortality statistics are not a satisfactory basis for generalization, and the probability that the author's conclusions may have been influenced by the surface aspects of the figures referred to is suggested by several of his statements.

The great reduction in infant mortality and in deaths from communicable diseases in recent years has postponed death, in such cases, to later dates, and the lives thus prolonged are usually sustained by diminished vitality. It is reasonable to expect that the *average* general health of the community has been reduced, and the *average* death-rate during subsequent years increased, by these extended lives. Consistently, if a substantial number of these previously short lives has been extended to the forties and fifties, the *average* age, at death, of all persons passing the age of forty will be reduced. The ratio of the number of persons reaching the age of fifty to the total population will also be reduced.

The increasing mortality due to certain organic diseases is frequently referred to in current discussions as indicating a greater susceptibility to such diseases, induced by changes in our manner of living or by the devitalizing influence of organic stresses incident to more strenuous activities. There is absolutely no foundation in fact or experience for such beliefs. More people escape death by croup, diphtheria and smallpox than formerly, but, as all must ultimately die,

it is inevitable that there should be a corresponding increase in the number of deaths from other causes. We have reason to expect a continued reduction in mortality from tuberculosis, typhoid and other prevalent diseases in the future, which should appreciably prolong the average span of human life. As many of these lives will be terminated later by cancer and diseases of the heart, it will be absurd to draw alarming inferences from subsequent statistical reports showing increased deaths from these causes.

J. T. RYAN

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QUOTATIONS

SIR NORMAN LOCKYER AND THE EDITORSHIP OF "NATURE"[1]

THIS book is essentially for those who know and use *Nature* and knowing it wish to understand the man who brought it into being—as a child of quite unusual vigor and distinction—giving to it, almost from its birth, the individuality and strength of character which have long made it everywhere the recognized organ of scientific opinion: the *Times* of science. The achievement was his great contribution to scientific advance, of far greater value, I venture to say, because of the effect it has had in promoting the appreciation of scientific endeavor, than his work as an inquirer—which was largely that of a seer, in advance of his time, needing interpretations that only later additions to knowledge were to make possible. Still, the spirit of discovery was at the root of his being: from it he derived his force and it gave to him his success. Wise men like Huxley, seeing this in him, became his willing slaves.

The establishment of *Nature*, now fifty-nine years old, was a literary, not a scientific, feat, yet one needing for its success a rare combination of qualities—not merely literary but also editorial ability, breadth and intensity of scientific outlook and social qualities of an unusual force and range. The journal was not a financial success until after thirty years. To have kept the enterprise alive, during so long a period, was an astounding exercise of determination, diplomacy and skill. Lockyer was never an easy man to get on with. At times impetuous, often intolerant, always impatient beyond measure and most assertive, from an early date he held scientific workers generally at his behest. His whole-hearted unselfish devotion to his enterprise, his high aims, the importance to us of its success, the difficulty of the work—were so clearly recognized that we all rallied to his standard. There was a feeling that the journal had to be. *Nature* is a power to-day because of the sure foundations he laid: upon this his successor—long his assistant and most severely trained in his service—during the past nine years, has been able to build broadly and judicially, to meet the needs of all schools of scientific activity and opinion, without fear or favor. *Nature* has been lucky in her assistants—Keltie and Gregory. Is the succession secure? I tremble, in asking the question, by the way.

In this connection, I may direct attention to the following passage in "The Earlier Life and Letters of Walter H. Page":

> Consider the making of a periodical: what is the difference between a fairly good one and a really great one? It is only the difference of personalities and ideas that go into them. This is so simple that it sounds silly to state it. But there is no secret about making a great magazine. You must have, of course, a good craftsman at the head of it, a man of editorial skill, of good judgment, of some courage and of character, but these are all common qualities and with all these you will make but a fairly good magazine. The stuff to make a great periodical of is yet lacking and this stuff is a prodigality of ideas—such as no one man has or can have. Ideas must grow about it with the very luxuriance of nature, must come to it from every quarter. It must have enough waste material to make all the other periodicals better than they are now. This requires more than the acquaintance and good-will and casual suggestions of fertile men; *it requires, to a degree, the identification of their personalities with it* (my italics).

It is because Lockyer was preeminently successful in securing "the identification of the personalities" of scientific workers and of advanced scientific opinion of the day with his journal that he made *Nature* what it is and that his successor is successful. Page necessarily feigned modesty in appraising the qualities needed in an editor and set these far too low. Editors must be peculiar people to succeed: far more than good craftsmen. *Nature* has been a success, because Lockyer wove for it a magic carpet upon which scientific workers in all subjects could be attracted to sit: to preserve this in effective condition can never be an easy task.

The story of Lockyer's life and work is told in the book in a general biography covering 226 pages, written by Professor H. Dingle, upon material com-

[1] From a review in *Nature* by Professor Henry E. Armstrong of the "Life and Work of Sir Norman Lockyer," by T. Mary Lockyer and Winifred L. Lockyer, with the assistance of Professor H. Dingle, and contributions by Dr. Charles E. St. John, Professor Megh Nad Saha, Sir Napier Shaw, Professor H. N. Russell, the Reverend J. Griffith, Sir Richard Gregory and Professor A. Fowler. Macmillan and Company.

piled by Miss Lockyer and Lady Lockyer with remarkable completeness. Then follow chapters by various writers appreciative of the several sections of his scientific and special work. From the general biography, we learn everything material in his career —in fact, it is possible to trace almost his daily occupation. Although most explicit, in a measure, the account is rather lacking in feeling—it is the work of a writer who has not known his subject sufficiently closely and at the early critical period of his activity to paint a really intimate picture. It is, in fact, as are so many portraits—technically good yet not quite the man himself. At times, the story is a little exaggerated, if not misleading, at least to one who, like myself, lived through the period under notice and was a close follower of all that happened, even sometimes behind the scenes. Probably Lockyer is best summed up in some of the doggerel current in early days: such as—

There was a young astronomer called Lockyer,
Who each year grew cockier and cockier,
Till he thought he was owner of the solar corona,
Did this young astronomer Lockyer;

or the following amusing item in a program of an entertainment on shipboard on one of the eclipse expeditions to India: "Mr. Lockyer will play upon his own trumpet: Wait until the clouds roll by!"

In early days, Lockyer was irrepressible, overflowing with energy and enthusiasm, at times displaying an overmastering tendency to fill the picture, often making the rashest assertions. The unco' guid dryasdusts were a little shocked by such conduct. Fortunately he had a large circle of friends able to discount his little foibles, who gave him their support. The element of a strong personal vanity was undoubtedly there, you saw it in him, yet behind all such display there was clearly nothing but generosity and the desire to make others share with him the intensity of his belief in the value of scientific purpose. He had no academic training; to his great advantage, I think, he was self-taught and unhampered by professional prejudice.

REPORTS

THE CENSUS OF 1930

Plans are being made for the 1930 census of population to be taken next April. A conference was held recently at the Department of Commerce by Secretary Lamont, census officials and members of the advisory committee appointed to consider the range of inquiries to be included in the questionnaires.

Dr. Louis I. Dublin, statistician of the Metropolitan Life Insurance Company of New York, was named chairman. The New Yorkers and others present at the conference were:

A. W. Page, vice-president American Telephone and Telegraph Company, for President Walter S. Gifford.

N. W. Barnes, International Advertising Association, 420 Lexington Avenue.

Dr. Robert E. Chaddock, Columbia University.

Edgar Sydenstricker, Milbank Memorial Fund, 49 Wall Street.

Dr. C. Luther Fry, Institute of Social and Religious Research, 230 Park Avenue.

Dr. Thomas Jesse Jones, educational director of Phelps Stokes Fund, 101 Park Avenue.

William Carpenter, National Electric Light Association, 420 Lexington Avenue, for Preston S. Arkwright, president.

Dr. Warren S. Thompson, director of the Scripps Foundation for Research in Population Problems, Miami University, Oxford, Ohio.

Fred Bremier, Curtis Publishing Company, for C. C. Parlin.

W. W. Husband, Assistant Secretary of Labor.

Dr. E. Dana Durand, of the Bureau of Foreign and Domestic Commerce.

J. Chester Bowen, Bureau of Labor Statistics.

L. W. Wallace, American Federated Engineering Societies.

William Green, president of the American Federation of Labor.

William M. Stuart, Director of the Census.

Joseph A. Hill, assistant to the director.

Dr. Leon E. Truesdell, chief statistician for population.

A review of the work of the Advisory Committee for the census of population made public on July 31 by the Department of Commerce follows in full text:

The afternoon session of the committee was devoted mainly to a further discussion of some of the topics left over from the morning session and to the approval of resolutions covering a number of points.

Resolutions passed by the conference on the population census included the following:

1. With regard to the elimination of the item of mother tongue. This committee is in accord with the decision of the Census Bureau.

2. The committee approves the questions on unemployment.

3. The committee is opposed to the inclusion of the suggested question on number of rooms per family.

4. The committee is opposed to the question on income of wage or salary workers.

5. The committee is opposed to the question of religious affiliation.

6. The committee is opposed to the addition of the question on ownership of radio sets.

7. The committee is opposed to the inclusion of the suggested group of questions on children born (number of children born to each married woman, number of these children living, age at first marriage [or duration of marriage], whether first, second or later marriage), and recommends that the executive committee give favorable consideration to the inclusion of these items in a special sample inquiry.

8. The conference desires to emphasize as a general principle that the population schedule should be used only for the purpose of completing enumeration and should be confined therefore to those items for which information on every individual is necessary and should not include items for which data can be collected in special surveys, or by canvassers of samples of the population.

In accordance with this principle the conference is of the opinion that the schedule should be restricted to the minimum item of the items but recommends that the director take into consideration a supplementary family schedule for a sample of the population to include several important items for which a special enumeration is not needed or practicable, the choice of which items to be left for consideration by the executive committee of this conference.

9. That a question be added to the schedule to determine the extent of migration between farms and cities during 1929. The schedule already contains a question as to farm residence on the census date. The additional question would read, "Did this person live on a farm 12 months ago?" and the migrants would be those persons who answered "Yes" to one question and "No" to the other.

10. The conference strongly approves the proposal of the Census Bureau to draw up a family card and recommends that the details of this card be left to the executive committee in consultation with the director.

11. The committee authorizes the chairman to appoint an executive committee to work in conjunction with the director.

At a recent meeting of the full advisory committee, made up of representatives from a wide range of business, governmental and other organizations, such as the American Federation of Labor; the Curtis Publishing Company; the Department of Labor; the National Electric Light Association; the Scripps Foundation for Research in Population Problems; the Institute for Government Research; Columbia University; the Metropolitan Life Insurance Company; the International Advertising Association, and similar interests, it was recommended that a small executive committee be named by the Secretary of Commerce to carry on the work of the full committee.

The nominations for the executive committee as recommended by the parent advisory committee have been approved by the Secretary of Commerce as follows:

Dr. Louis I. Dublin, statistician, Metropolitan Life Insurance Company, Madison Square, New York City.

Dr. Robert E. Chaddock, Columbia University, New York City.

Dr. Lewis Meriam, Institute for Government Research, 28 Jackson Place, Washington, D. C.

Edgar Sydenstricker, Milbank Memorial Fund, 49 Wall Street, New York City.

Dr. Warren S. Thompson, director, Scripps Foundation for Research in Population Problems, Miami University, Oxford, Ohio.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

CONSTRUCTION OF MICRO-THERMOCOUPLES

THE purpose of this paper is to describe a method of constructing micro-thermocouples which are small enough and at the same time strong enough to be inserted by means of a micro-manipulation instrument into small living cells or into tissues. They are small enough to be used in measuring light absorption of a single plastid or for any purpose requiring temperature measurements at minute points.

The method of drawing various metals in glass to wires or filaments of exceedingly small size was first employed by G. F. Taylor.[1,2] The same method was independently discovered a few months later by C. V. Taylor[3] in the construction of microelectrodes and micromagnets.

If a small wire of nearly any metal is inserted into a slightly tapered capillary of glass or quartz until it fits tightly and the region of tight fit is melted over a very small gas or oxygen-gas flame, a sudden pull will draw the glass and metal to microscopic dimensions. Glass-covered electrodes less than one micron in diameter can readily be made. Certain requirements must be met, however, in choosing the metal and the glass. The coefficient of expansion of the metal must be at least as great as that of the glass

[1] G. F. Taylor, "A Method of Drawing Metallic Filaments and a Discussion of their Properties and Uses," *Phys. Rev.*, xxiii, p. 655, 1924.

[2] Fine wires made by this process may be obtained from Baker and Co., Newark, New Jersey.

[3] C. V. Taylor, "Microelectrodes and Micromagnets," Proc. Soc. Exp. Biol. and Med., xxiii, p. 147, 1925. See also C. V. Taylor and D. M. Whitaker, "Potentiometric Determinations in the Protoplasm and Cell-sap of Nitella," *Protoplasma*, 1927, iii, no. 1.

or on cooling the glass will shrink onto the metal and shatter. The melting-point of the glass must be between the melting-point and the boiling-point of the metal. Thus for platinum, iron and other metals of high melting-point capillaries of clear fused quartz are used.[4] For silver, pyrex glass has a suitable melting-point. For bismuth, solder, lead, etc., very soft soda glass can be used.

One of the difficulties encountered is the occurrence of gaps in the metal core, especially at the base of the taper. It has been found that these gaps can best be avoided by starting with wires which are at least as small as thirty gauge (B and S) and preferably thirty-five gauge.

In order that the microelectrode shall be strong and rigid and of low electrical resistance, it is important to have a fairly steep final taper. This taper should not be more than one half or one centimeter long. With practice short tapers can be drawn, especially if attention is given to two things: Only a small section of capillary should be melted (*i.e.*, the diameter of the burner should be less than .5 mm); the glass should not be too fluid at the instant of drawing, or it will become a long fine thread instead of drawing to a point.

The micro-thermocouple which is being described is simply a double electrode in which two different metals are used. They are joined at the tip to make the sensitive junction. The double electrode is made by taking two capillaries of equal size and of the same kind of glass, each containing one of the metals, and fusing the two capillaries together at the region which is to be drawn. They round up by surface tension to give a rod which in cross-section is more or less elliptical and contains the two metal cores entirely surrounded and separated by glass. This is drawn to microscopic dimensions in the same way as the electrode just described. After drawing, the two capillaries must be held very carefully in the fingers until they are joined at several points with De Kotinsky cement so that they will not move with respect to each other and break the tip.

Choice of Metals

Pairs of metals must be chosen which have a suitable thermal E.M.F. and which have melting-points near enough together so that they may be drawn in the same kind of glass. Some metals have an exceptional tendency when melted to separate into little beads. Constantan is difficult to use for this reason. Iron and platinum are a combination much easier to draw than copper and constantan, and with almost as high an E.M.F. (19 microvolts per degree). Another good combination of higher sensitivity is iron against an alloy of gold and palladium (Au 60 per cent., Pd 40 per cent.). This combination is drawn in quartz and has a thermal E.M.F. of about 45 mv. per degree. Still higher E.M.F. (95–100 mv. per degree) is obtained by using bismuth against an alloy of bismuth and tin (Bi 95 per cent., Sn 5 per cent.). These metals, which are too brittle to be made into wire, may be obtained already drawn in glass or as granulated metal from Baker and Company. It is more practicable to use the granulated metals and draw capillaries, as in this way the thickness of the glass covering can be varied to suit needs. It has been found best to make the walls about as thick as the metal core since almost the entire strength is provided by the glass. Too thick a wall, however, is more difficult to remove with HFl (see below).

Cutting Off the Tip

The double electrode is cemented to a glass holder and is held in a micro-manipulation instrument. In the mechanical stage of the microscope a slide is held bearing a small piece of razor blade, with vertical edge, to be used as an anvil. A diamond splint[5] with a sharp point mounted on a glass rod is held in the other arm of the micro-manipulator.

Under the microscope (about 100 diameters magnification is usually sufficient) the electrode is placed across the razor blade. By means of the diamond the side of the electrode is scratched. The electrode should now be rotated through 180° and scratched on the opposite side. Then with the scratch on the razor blade, the diamond is used to push against the electrode further out toward the tip. The electrode will usually snap off squarely through the scratches, with the two metal cores now ending (abruptly) flush with the end of the glass (Fig. 1a).

Removing Glass from the Tip

In order to project the embedded wires beyond the glass or quartz so that they may be joined, a section of the glass is removed. The most satisfactory way to do this when the wires are of metals of some shearing strength is to scratch both sides of the glass a

[4] A very good grade of clear fused quartz tubing may be obtained from the Hanovia Chemical and Manufacturing Co., Newark, New Jersey. Heavy walled tubing (about 5 mm outside and 2 mm inside diameter) is best for drawing electrodes and thermocouples.

[5] Good selected splints may be obtained from the L. M. Van Moppes Diamond Company, Newark, New Jersey. An easy way to mount the splints is to put a ball of De Kotinsky cement on the end of a glass rod. Then holding the diamond in a pair of forceps, heat the base, which is to be embedded, in a small flame, and press it against the cold cement so that it melts its own way in.

short distance back from the end and break off the glass as in cutting off the tip (Fig. 1b, c). With care this can be done without breaking the wires in the case of Pt, Fe, Cu, Ag, Au-Pd, etc. The wires are left bright and clean. But if a very small junction is being constructed, that is, with total diameter less than five or ten microns, it is difficult to avoid breaking off the wires. In this case the glass or quartz may be removed by dipping the tip in hydrofluoric acid[1] to the desired depth. A small drop of the acid is placed on a horizontal paraffined slide in the

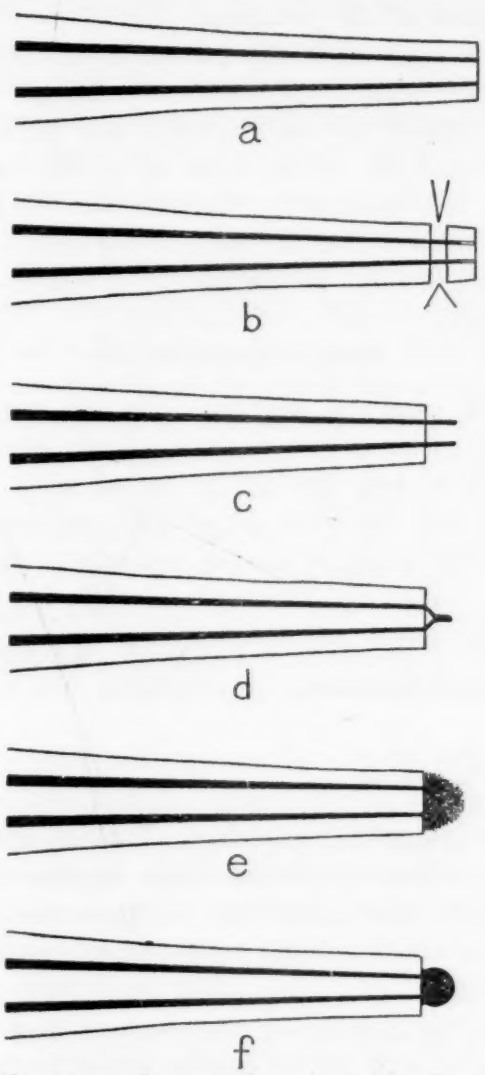

FIG. 1. Diagrams of successive stages in the construction of the micro-junction.

mechanical stage of a horizontally tipped microscope. The electrode is held in a manipulator and dipped in from above. A piece of glass slide held over the objective of the microscope with paraffin protects the lens from acid. In some cases the acid fumes destroy the glass of the electrode too far up the stem. This can be checked by first dipping the electrode in hot paraffin, which can be removed from the tip alone with xylol and 100 per cent. alcohol, or by cutting off the tip so that no paraffin covers the end. After the acid process the electrode should be washed in distilled water and then dipped in a strong base to stop the action of the HFl.

In removing glass from the tips of electrodes of Bi and Bi-Sn the acid method must be used even for larger sized electrodes, as it is practically impossible to cut off the glass without also shearing these soft metals. Strong acid will remove glass from small tips in a few seconds. Twenty minutes or more is required for larger tips. The disadvantage in the use of acid is that the glass of the stem is usually somewhat corroded so that it is less trustworthy as an insulator, and the wires of the tip are left with a thin film of corroded glass and salts which it is difficult to remove.

JOINING THE TIPS

The tips may be joined by soldering, welding or electroplating. Electroplating is by far the most satisfactory method when practicable, because all methods involving much heating tend to oxidize most of the metals and prevent good contact. Wires may be joined by electroplating which are too small to be handled mechanically. The success of electroplating in making a stable junction depends on having the wires rigidly stationary with respect to each other. This condition is met in the process of double drawing.

The first step is to bend the two wires together so that they touch or almost touch (Fig. 1d). In the case of exceedingly fine wires which are already very close together this step may be omitted.

Silver is a good metal to deposit. It has high heat conductivity and is comparatively inactive. It may be deposited from any standard silver-plating solution and makes a good smooth coating which is quite strong.

The depositing can be done under the microscope by means of a hanging drop on the under side of a supported coverslip. One dry cell supplies a suitable potential. A delicate regulation of deposit rate can be made by placing a moistened finger across an open switch and varying the pressure of contact. The positive electrode is a silver wire held in one arm of the manipulator. First one of the micro-wires should be connected to the negative terminal by its lead and a thin coat deposited. Then the first lead should be disconnected and the lead of the other fine wire should be made negative. As the deposit builds up on this second wire contact will be established with the first wire which will now also receive deposit. All the current which deposits silver on the first wire now passes through the plating which joins the wires. This keeps the thin connection charged with respect to the solution and causes it to be continually thickened by deposition. When enough silver has been deposited (Fig. 1e) the junction should be washed in distilled water and thoroughly dried.

If the two leads of the junction are now connected through a spring switch to a single dry cell, one very quick tap of the switch will usually melt down the silver plating which rounds up by surface tension to form a neat solid ball in which the two wires are embedded (Fig. 1f). This makes a strong junction which can be readily inserted into tissues or cells with no change in electrical resistance. The comparatively low melting-point of silver is an advantage in this process of melting down. Its comparatively high coefficient of exapnsion causes it to contract tightly onto the wires when cooling.

Because of the low melting-points and lack of cohesion of Bi and Bi-Sn, it is practically impossible to melt down the plating on junctions of these metals without also melting and destroying the cores. This is so even when tin is used in plating (melting-point 232°) and even when heat is applied with a small filament. Junctions of these metals which are joined by unmelted silver plating maintain constant resistance if carefully handled and if only minute currents pass through them. With frequent calibration they may be satisfactory for use when mechanical strength is not required. The plating is not stable enough for inserting into cells. More rigid junctions of these metals may be made with somewhat more difficulty by bending the wires, which are much less brittle than large wires, into mechanical contact and melting them together under the microscope by means of a small filament held in the manipulator.

PROPERTIES

The resistance of the junctions varies greatly with size (inversely more or less as the square of the diameter), steepness of taper (or length), success of joining at the tip, and with the metals used. Iron and platinum junctions which are ten microns in diameter have a resistance of around ten or fifteen ohms (including two short leads of thirty-five gauge wire). Bismuth and bismuth-tin junctions have considerably greater resistance.

The temperature lag is negligible because of the minute mass of the junctions.

With a high sensitivity galvanometer such as the Leeds and Northrup all copper circuit type HS, with proper external critical damping and with a four-meter beam, the temperature of a Bi and Bi-Sn junction ten microns in diameter can be measured directly, without thermal relay, to less than 0.0005° C. (provided the rest of the system is constant within this limit).

OTHER APPLICATIONS

If both cores are platinum, the tips may be left unjoined (Fig. 1c) to form a minute bipolar electrode which may be lightly coated with platinum black. Such tips when joined with platinum form a filament which may be used as a minute source of light or heat. When the tip in air is white hot the cores within the quartz are red hot.

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SPECIAL ARTICLES

THE EARTHWORM FAUNA OF THE UNITED STATES

"THE fauna of this country is well known; only relatively insignificant questions of minor detail remain to be worked out." This is a dictum frequently expounded to-day by zoologists. Perhaps certain classes have been exhaustively studied, but at least one group of common animals has been neglected. The particular group to which reference is made is the Oligochaeta and especially that section of the class which includes the forms commonly called earthworms.

Survey of zoological literature shows that Frank Smith is the single American to make an extended investigation (1895–1924) of these animals. He worked out, perhaps fairly completely, the earthworm fauna of a smallish region centering in Illinois. A Swede, Gustaf Eisen, published a series of papers (1874–1905) on North-American oligochaetes, but except for some half dozen forms from the state of California, practically all of the species described were Mexican or Central American. Papers by Garman, J. P. and H. F. Moore, Smith and three foreign oligochaetologists—Michaelsen, Perrier and Ude—containing descriptions of single species or reports on random collections from widely separated localities complete the bibliography on the earthworms of this country.

In a large portion of the glaciated area of North America we can not, of course, expect to find indigenous species of earthworms. This part of the continent is inhabited only by peregrine Lumbricids presumably introduced by man. It should not be without interest, however, to know what species have been so introduced, or more accurately, have been able to "occupy the land" after introduction, and how they have distributed themselves in the new regions. Comparatively little information of this sort is available. To illustrate: a student in the graduate school of Harvard University, while smoking an after-lunch pipe, on a pleasant May day a year ago, picked up seven species of earthworms from under leaves on the grounds of the Museum of Comparative Zoology. The worms in this small collection have been identified as follows:

Helodrilus caliginosa typica
" " *trapezoides*
H. (Eisenia) foetidus
H. (Dendrobaena) subrubicundus
H. (Bimastus) tenuis
Lumbricus castaneus
L. rubellus
L. terrestris

Only three of these species are known to be common: *L. terrestris* is usually known as *"the common earthworm,"* although *H. caliginosus* and *Eisenia foetida* can be secured, so far as the writer's experience is concerned, in larger numbers and with much greater ease than the so-called common form. The remaining species, judging only of course from the published records, are much rarer. None have been previously recorded from the state of Massachusetts: only one, *B. tenuis,* has been previously reported from any New England state (Maine). *L. castaneus* has been hitherto recorded only twice from this continent, once from New York State, once from Canada.

The glaciated areas of the continent are not, however, entirely devoid of the more interesting indigenous forms, for endemic species of earthworms have penetrated northwards since the last retreat of glacial ice. The extent of this penetration is yet to be discovered, and when related to the time during which the movement has taken place will doubtless offer valuable evidence towards a solution of other more complicated and perplexing problems of earthworm migration.

In the unglaciated regions of the United States there have been found endemic species belonging to three important subfamilies of the Oligochaeta. Some of the questions of minor detail that yet remain to be worked out may be best indicated perhaps by merely listing the endemic species together with the records of their distribution.

SUBFAMILY MEGASCOLECINAE

Plutellus. The genus founded for *P. heteroporus* from Pennsylvania by Perrier in 1873. The type species has not been seen since. A letter to the editor of *Nature* (1890) by the English oligochaetologist, Benham, pointing out the need for further study of the species and urging the collection of further specimens was without result. Four other American species of the genus have been found in California.

Megascolides. M. americanus was described in a preliminary note by Smith (1897). It has not been seen since. The worms were 180 to 190 mm long, with a diameter of 6 to 7 mm, and were obtained in a road cutting near Pullman, Washington. The absence of additional records may possibly be explained by the fact that the burrows of this worm extend into the ground to a depth of at least fifteen feet.

SUBFAMILY DIPLOCARDIINAE

Diplocardia. The most characteristic American genus, confined to the United States with the exception of two species, one of which is limited to Mexico, the other occurring in both Lower California and Chillicothe, Texas. *D. communis* has been found in Illinois;[1] *D. singularis* in Illinois, Indiana and Raleigh, N. C.; *D. eiseni* in Florida and Savannah, Ga.; *D. riparia* in Illinois and Indiana; *D. verrucosa* in Omaha, Illinois and Nebraska; *D. michaelseni* in Raleigh, N. C.; *D. udei* in Indiana and Raleigh; *D. longa* in Pulaski County, Georgia; *D. floridana* in Monticello, Florida; and *D. mississippiensis* in McNeill, Miss.

SUBFAMILY LUMBRICINAE

Helodrilus

Eisenia. H. (E.) carolinensis, founded for a single specimen obtained at Hamburg, Germany, in a shipment of plants from Fayetteville, N. C., in 1903. It has not been seen since. *H. (E.) lönnbergi* has been found in Savannah and Raleigh. The writer recently found unidentified specimens of this species from Mount Vernon in the collections of the Smithsonian Institution in Washington.

Bimastus. The subgenus is probably limited to the United States. *B. palustris* has been collected in Pennsylvania, New Jersey and Raleigh; *B. tumidus* in Mount Lebanon, New York; *B. giesleri* in Savannah, Florida, Ohio, Illinois, Kansas and Texas; *B. zeteki* in the Susquehanna River, New York; Douglas Lake, Michigan, and Urbana, Illinois; *B. welchi* (one specimen only) in Manhattan, Kansas.

INCERTAE SEDIS

Hypogaeon hirtum Savigny 1820, from Philadelphia. This very interesting form has nine parallel rows of spinelet covered setae. The original specimens were given to Savigny by Cuvier. The species has not been seen since. Vaillant wrote (1889) rather plaintively that "il est singulier que dans le pays d'ou proviendrait ce ver, alors que les recherches zoologiques y sont poussees avec tant d'ardeur, on ne paraisse pas l'avoir encore retrouve."

Perchance in future intervals between the elaborate and costly expeditions to far distant tropic or arctic shores some of our zoologists may find time to attempt the exploration of our own backyards.

G. E. GATES

JUDSON COLLEGE,
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[1] The name of the state is given when the species has been recorded from two or more localities therein.

THE RELATIONSHIP OF BLACK CHAFF DISEASE OF WHEAT TO CERTAIN PHYSICAL AND PATHOLOGICAL CHARACTERS[1]

BLACK chaff disease of wheat affects various parts of the spike and often the adjacent culm area. The lower portion of the culm is also commonly affected. This bacterial disease, caused by *Bacterium translucens undulosum,* was first described by Erwin F. Smith,[2] and is considered to be seed borne. It is recognized that the disease may, at times, cause serious losses, but quantitative loss estimates are meager.

The writer has recently made studies upon families of the F_3 generation of hybrids secured from crossing the wheat variety Hope with Reward, Florence and with certain Marquis-Kota hybrid selections. Hope is susceptible to black chaff, but has shown essential freedom from stem rust and from bunt, or stinking smut. The Marquis-Kota selections used are resistant to stem rust, but are susceptible to black chaff. Both Reward and Florence show some resistance to black chaff, but are susceptible to stem rust. Data were secured with respect to the relationship of black chaff to weight of grain per one thousand kernels, and to number of fertile stools per plant, and also the relation of amount of black chaff to two other diseases, stem rust and bunt. In each F_3 family, plants were separated into three groups upon the basis of black chaff present. The three groups, A, B and C, were not represented in all families as an effort was made to secure a uniform classification from family to family.

In the nine families studied coming from the two rust resistant parents, stem rust was nearly absent. In these nine families nineteen comparisons are possible between family components. In seventeen of these comparisons the family component with the smaller amount of black chaff had the largest weight of grain per one thousand kernels. In the other two cases, the difference was of no moment. It was possible to compute correlation coefficients using Pearson's bi-serial method. All the nine coefficients were negative, and seven of these nine showed significance. The decrease in weight of grain per one thousand kernels as an average of several families was 10.5 per cent.

The data indicate that the presence of black chaff affects the number of fertile culms per plant. The variability of culms per plant was too great to allow the use of probable errors for the various black chaff components, considering the small differences involved. Minus and plus changes between the components were considered and thirty-five out of the forty-seven possibilities showed a decrease of fertile culms per plant with an increase of black chaff. In comparison with equal possibilities, the odds are 1,350 to 1 against a deviation so great being due to chance alone. If this difference in number of fertile culms is actual, and if no other causal agent is concerned, it is evident that the black chaff disease has a deterrent effect upon the development of the plant from its early stages.

Both rust and black chaff were commonly present in those families derived from the Hope-Florence and Hope-Reward parents. In the seventeen families derived from the Hope-Florence and the Hope-Reward parents, three contained plants carrying essentially no rust and one family had but one black chaff component. It was possible to secure correlation coefficients in twelve families by the bi-serial method. In one family the correlation was essentially zero. In eleven families the correlation was negative and in seven of these cases it was significant. The maximum negative correlation was -0.886 ± 0.035. Rust was light in all family components, the maximum average being 9.0 per cent. This antagonistic relationship seems to be decidedly pronounced in these two crosses.

Only a limited amount of material was harvested upon which data could be secured relative to the relationship of bunt and black chaff. In the majority of cases, families carrying much bunt were not harvested. Bunt was present in only four available families in an amount sufficient to allow correlation coefficients to be determined. These four families trace back to rust resistant parents, Hope x Marquis-Kota hybrids. In one instance, the correlation of bunt and black chaff was essentially zero. With one family, containing 265 plants, the coefficient was -0.677 ± 0.041. In the other case with 72 and with 204 plants, the coefficients were -0.276 ± 0.096, and -0.273 ± 0.061, respectively.

Evidently, it is not possible to conclude, with the data at hand, whether this relationship between black chaff and stem rust and between black chaff and bunt has a physiological or genetic basis. The writer is of the opinion that the evident antagonism is conditioned by physiological relationships. It is evident that in any studies of inheritance of stem rust or bunt, regard must be had to the presence of the black chaff disease when present. Also in greenhouse cultural rust inoculations it is of importance to use plants not infected with black chaff. In rust garden work, it is evident that accurate rust readings or bunt determinations could not be made if the plantings had been infected with black chaff. In uniform rust nurseries rust readings should be made having in mind the amount of black chaff present.

L. R. WALDRON
NORTH DAKOTA AGRICULTURAL COLLEGE

[1] Paper from the North Dakota Agricultural Experiment Station. Authorized by the director.

[2] "A New Disease of Wheat," *U. S. Dept. Agr., Jour. Agr. Research,* 10: 51–54, 1917.

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PAPERS BEFORE THE MINNEAPOLIS MEETING OF THE AMERICAN CHEMICAL SOCIETY

RICKETS is fundamentally a bacterial disease, caused by the poisonous products of bacteria in the digestive tract. Vitamin D prevents this distressing ill of childhood primarily by killing off a large proportion of these harmful microorganisms. These claims, differing radically from the concepts now orthodox in physiology, were advanced at the meeting of the American Chemical Society by Lester Yoder, chemist at the Iowa Experiment Station, Ames. He was led to his conclusions by a study of the bacterial population of the intestinal contents before, during and after the administration of vitamin D. While his experimental animals were receiving the vitamin the bacterial count fell off markedly, but increased again when the vitamin was discontinued. For this reason the Iowa chemist suggests the possibility of using vitamin D as a means for the general control of the bacterial growths within us, as well as for the specific cure or prevention of rickets. Studies on vitamin D in the test-tube as well as on its physiological effects have confirmed Mr. Yoder in his opinion that it exerts its principal effects without leaving the digestive tract. Pure ergosterol, which is the stuff that becomes vitamin D when ultra-violet light has shone upon it, is almost insoluble in water. After exposure to ultra-violet radiation it becomes even more insoluble. In this condition it would be extremely difficult, if not impossible, for it to pass through the intestinal wall and be absorbed into the circulating blood. For this reason it exerts its chief influence during its passage through the digestive tube, and not in the circulatory system.

THE basal metabolism, or general level of physiological processes, is raised in women as the result of the presence in their blood of the hormone or internal secretion of the sex glands. Results of researches indicating this were presented by Professor J. F. McClendon, of the University of Minnesota. Working with human volunteers, he found that a large injection of the ovarian hormone into the blood-stream where none was present would raise the basal metabolism so high that it remained seven per cent. above normal 24 hours after the injection. Smaller injections raised it for a few hours only.

A REGULAR regimen of cod-liver oil is helpful to underweight school children suspected of being incipient or arrested tuberculosis cases, according to Dr. Arthur D. Holmes, of Stoneham, Mass. With Miss Hanna L. Ackerman and Miss Madeleine G. Pigott, he conducted tests on a group of school children from tuberculous surroundings. At the end of the investigations, the records showed a definite increase in body weight and a lowering of abnormal temperatures. There was also an improvement in general health and in quality of school work.

MAKING germs step up and get killed by new disinfectants and antiseptics, to get an idea of the strength the latter substances will have when used in active service, is one of the tricks of the trade in modern bacteriology. One of the most evil of germs, the gonococcus, the cause of one of the so-called social diseases, is employed in this way by Herbert C. Hamilton, of Detroit. He described his technique for using this dangerous organism in standardizing germicidal chemicals.

A FLAME so intense as to melt its way through any known solid substance is produced by a new type of blowpipe, employing finely powdered aluminum instead of the more familiar hydrogen or acetylene gases. The new invention was described by Dr. Frank M. Strong, of Syracuse University. Dr. Strong described his device as follows: "A screw conveyer carries a slow stream of aluminum dust from the bottom of a hopper out through the open end of a brass pipe. The dust is here met by a swift cross-stream of oxygen, with which it forms a fine and uniform suspension. From this point the mixture is passed forward through a larger tube, which farther along is divided up into eight smaller tubes. The latter diverge from the central tube for a short distance, and are then curved back inward so as to come to a sharp focus. The aluminum-oxygen flame can be lighted at this focus point with a match or Bunsen burner." Dr. Strong's blowpipe combines the principles of the familiar oxyhydrogen or oxyacetylene blowpipes with that of thermite, a powder used for the generation of intense heat on a limited area, such as the ends of rails in welding. Thermite consists of aluminum powder mixed with another chemical which on heating yields free oxygen at a rapid rate. In the new blowpipe the oxygen is supplied directly in the form of a gas instead of being generated on the spot from a chemical.

ETHYLENE, the gas now used extensively to bring stored fruits to a ripe color, to blanch celery, and for other purposes, appears to be harmless to animal life if there is not much of it in the atmosphere. Furthermore, it has no effect on most of the processes of digestion, and may even facilitate the digestion of starch. These conclusions appear to be justified on the basis of a report made by Dr. Arthur D. Hirschfelder and Elmer T. Ceder, of the University of Minnesota. They report that young rats given water saturated with ethylene did not have their growth checked by it, nor did other rats suffer slowing down of growth when they lived in an atmosphere containing a low concentration of the gas. An atmosphere containing one per cent. of ethylene, however, did inhibit growth. Pepsin, trypsin and lipase, digestive juices that act on proteins and fats, were neither helped nor harmed by being saturated with ethylene, but amylase, the principal digester of starch, had its action augmented by similar treatment. Ethylene alone did not convert starch into sugar, the chemists stated.

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BREAKING up a low-grade fertilizer and pushing its essential elements more compactly into another combination, as one might unpack three loosely-filled trunks and cram their contents into a single tightly-filled one, is a feat that is occupying much attention on the part of industrial chemists now-a-days. E. L. Larison and R. J. Caro, of the Anaconda Copper Mining Company, are carrying on this process, in the interest of saving bulk and economizing on freight and truckage charges. Among the most widely used classes of fertilizers are the phosphates. A peculiarity of phosphates is that they can exist in three forms—three degrees of chemical packing. The basic metal—calcium, usually—can carry either one, two or three units of phosphoric acid. Since the phosphoric acid is what the farmer especially wants on his field, the triple phosphate is the most desirable form, from the point of view of economy in handling. In nature, however, phosphate rock usually occurs in the single, or monophosphate form. The trick of the manufacture is to break off the phosphate portion of part of this rock, and tack two units of it on to a calcium atom already carrying one unit, thus converting the monophosphate into the more concentrated triphosphate. Another trick of double packing in fertilizer manufacture carried on by the Anaconda firm is the combination of ammonia with phosphate. Crops want nitrogen as well as phosphorus, and ammonia contains nitrogen. Therefore a fertilizer combining the two satisfies two needs of plants at one application, again resulting in an economy in handling.

PUMPING a nitrogenous gas through crushed and moistened phosphate rock is expected to yield an improved commercial fertilizer according to Edward J. Fox and Dr. J. W. Turrentine. Their researches were the result of a desire to find a wider use for the products of manufacturing plants that capture nitrogen from the air and combine it with other elements to form fertilizer material and other chemicals. The three mineral nutrients needed in largest quantity by most crop plants are nitrogen, phosphorus and potassium. This country has great deposits of phosphorus-bearing rocks of various kinds, and if the same mineral can be made to carry nitrogen as well as phosphorus, there will be that much less dead weight to transport to the field. The two government chemists found that by passing nitrogen, in the form of nitrogen peroxide, through slightly moistened masses of phosphate rock, they could secure the combination of a considerable proportion of this valuable element with the phosphates, at the sacrifice of a fraction of the phosphorus. This makes a double fertilizer out of the rock, leaving only the potash to be added. The work so far has been on an experimental basis, and the problems of factory-scale production have yet to be solved. But Mr. Fox and Dr. Turrentine are confident that this end can be successfully attained.

THE potash production from American mineral beds is increasing rapidly, but not as rapidly as the national demand for this important fertilizer, according to Dr. J. W. Turrentine, of the U. S. Department of Agriculture. The world production in 1928 may be conservatively estimated at something over 1,900,000 tons of actual potash. In the United States production amounted to 104,000 tons of potash salts, equivalent to 60,000 tons of actual potash, valued at over $3,000,000. This represents an increase of 38 per cent. over the previous year's tonnage. During the same period, however, 976,000 tons of potash salts, representing a total value of $22,500,000, were imported for domestic consumption. This represents an increase of 33 per cent. in American importations.

THE creosoted wood conduits in which lead-coated telephone cables are sometimes cased for protection may, under some circumstances, become a menace instead of a means of preservation, according to R. M. Burns and B. L. Clarke, of the Bell Telephone Company. They told of discovering in the air contained in such conduits appreciable quantities of volatile acids capable of corroding the lead sheathing. They have devised a method of estimating the quantity of such acids present, and told of their findings on a number of different kinds of lumber.

ARTIFICIAL diamonds were predicted by Professor J. Willard Hershey, of McPherson College, Kansas. The most promising modern attempts at achieving this much-sought-for end were made about thirty years ago by a French scientist named Moissan. Taking up the work where Moissan left off, Professor Hershey has made some improvements in his technique and is hopeful of eventually producing good diamonds in the laboratory. His process consists of melting pure carbon with filings of various metals in an electric furnace, and then plunging the white-hot mass into an ice-cold saturated salt solution. The cooled mass is subjected to further chemical treatment, and then tested for diamond particles. "I have not yet succeeded in all that I hope to accomplish," said Professor Hershey, "but the largest diamonds produced at McPherson College are the largest genuine synthetic diamonds on record. It is no longer an unattainable goal to produce artificial diamonds in the laboratory, and it is believed that the difficulties that prevent the preparation of large and beautiful diamonds are only technical."

INDICATIONS of a possible future use for the sawdust that now makes useless and troublesome mountains around sawmills were contained in a paper presented by Professor W. H. Peterson, R. J. Allgeier and Professor E. B. Fred, of the University of Wisconsin. In a cooperative chemical-bacteriological research program, they have discovered how to make the powdery wood waste into acetic acid, the active principle of vinegar, and lactic acid, which is what makes sour milk sour. Both these acids have industrial uses that render their domestic significance an entirely secondary matter. Three steps were involved in turning wood into acid. The first was turning it into sugar, which was done by the old familiar method of treating it with a strong chemical, such as sulphuric or hydrochloric acid. Then the pulp was further treated with a carbohydrate-converting enzyme, contained in malt

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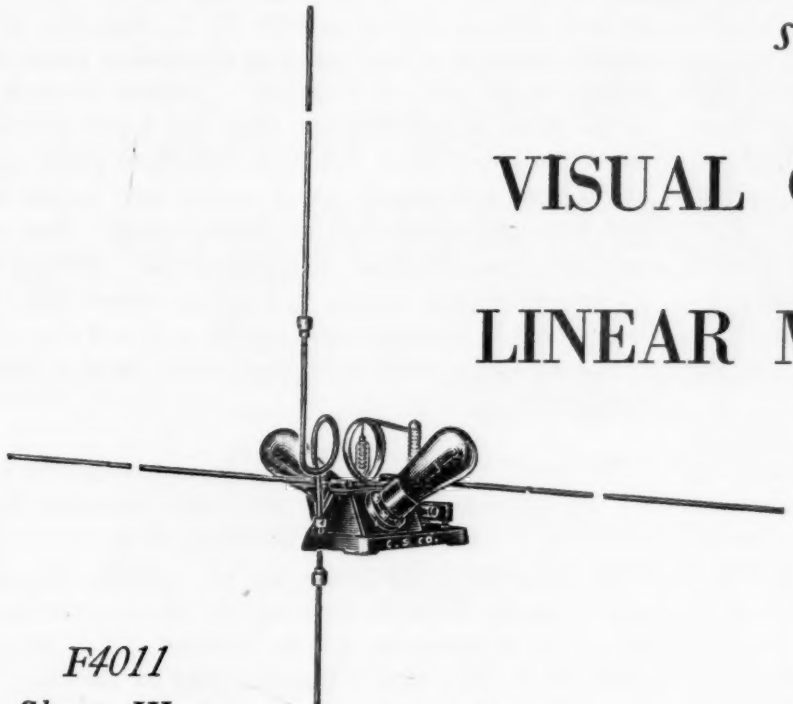

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sprouts. Finally, the process was completed by the addition of a microoragnism that has the power to ferment both hexose and pentose sugars into acid. From 80 to 90 per cent. of the sugar present was fermented, the resulting mixture of acids consisting of ten parts of lactic to one of acetic. Wood sugar produced by the Bergius process in Germany fermented equally well and gave the same yield and ratio of products.

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A test plane with a wasp 420-horsepower motor was especially devised for the giant camera. The ship has been carefully balanced with a minimum of vibration. It holds six passengers without the camera, but carries only two when the camera is in place.

Ordinarily the camera is suspended through a hole drilled through a section of the ship's bottom. While the picture is being taken the plane moves at a speed of about 85 miles an hour. The completion of an exposure, including the automatic setting and winding of the shutter, the rolling of the film and the "shooting" of the picture, takes only 15 seconds. During these operations the photographer has very little to do, since he has already set the automatically controlled mechanism to snap pictures at regular intervals varying from a few seconds to several minutes.

ITEMS

TWO petrified human brains have been found at Odinzowo, near Moscow, in central Russia, associated with the teeth of a woolly mammoth, and are said to be the oldest fossilized human brains ever found. It is reported that a commission of scientists has been selected to make detailed studies of these remarkable finds of man during the Ice Age when the huge mammoths and the rhinoceros were clothed with a thick coat of woolly hair. These finds are not "casts," but actually petrified human brains—somewhat shrunken, but sufficiently well preserved so that anatomists can reconstruct the form of the brains from the fossils. The Russian scientist, Hindze, who is preparing a report on the brains, is of the opinion that man in the Ice Age possessed a brain slightly smaller and less developed than recent dwellers of the same area.

THE site of a village dating back to the end of the New Stone Age has been discovered and excavated at Moedling, a picturesque town a half-hour's train ride from Vienna, and long a favorite haunt of artists. It stands on a low hill at a little distance from the town. Other relics of antiquity near by date back to the Middle Ages and to a time in the Iron Age, about 700 B. C., so that the history of human settlement here now runs more or less continuously from 4000 B. C., the date of the newly-discovered village, down to the modern times represented by the town of Moedling. Nothing much is left of the Stone Age settlement. Not even a post-hole shows where the houses were, but many blackened stones tell of hearth-fires, and fragments of pottery and broken stone and bone implements tell of housekeeping. One metal tool has been unearthed, a copper chisel. This is of a pattern similar to copper and bronze chisels that have been found in sites in lower Austria and in Saxony, indicating an early north-south trade route passing through this place.

THE problem of where birds go in winter may be solved by the assistance of radio. Professor Johannes Thienemann at a bird station at Rossitten, East Prussia, was able, by means of requests for information, *via* microphone, to get valuable check-ups on the movements of a group of storks released after number bands had been attached to their legs at the beginning of the fall migratory season last year. Band numbers sent in by interested members of his radio audience showed that five days after the storks' release on September 26, they were in the Carpathian Mountains of Czecho-Slovakia. By October 10 they were near Messini in the southwest of Greece, having flown approximately 1,250 miles in two weeks, almost due south. This checks previous experiments with stork migration made in Germany, but the use of the radio naturally speeds up considerably the process of gathering the required information. Whether the experiment will be repeated again this fall is not yet known.

DIVING animals, like ducks and muskrats, can be induced to hold their breath until they die from lack of oxygen. This strange phenomenon has been observed by Dr. Theodore Koppanyi, of Syracuse University. The nerve endings of the reflex that control holding the breath are in the nostrils, since pouring water over the nostrils induces it in both the duck and the muskrat. Besides this submergence apnea, as the feat of holding the breath is technically known, there is another respiratory adaptation in diving birds and animals by which apnea can be brought about by bending the head back on the neck while the animal is lying on its back. Dr. Koppanyi states that complete suspension of breath for ten minutes has been observed in this position. It is actually possible to kill the duck by maintaining this postural apnea until the animal dies from lack of oxygen. It is indeed a remarkable fact that inhibitory nervous influences can counteract the chemical stimulation of the respiratory center by the accumulated carbon dioxide in the blood.

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Bird Migration from the Point of View of Light and Length of Day Changes. H. A. Allard.
Variation and Correlation in Serially Situated Organs in Insects, Fishes and Birds. W. W. Alpatov and A. M. Boschko-Stepanenko.
The Reproductive System of Triploid Intersexes in Drosophila Melanogaster. Th. Dobzhansky and C. B. Bridges.
Genetical and Cytological Observations on Oryzaephilus Surinamensis. Donald B. McMullen.
Do Southwestern Quail Require Water? Professor Charles T. Vorhies.
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NOVEMBER–DECEMBER

Ovists and Animalculists. Professor R. C. Punnett.
An Alternative Criterion of the Differentiation of Birds which Die Antecedent to a Given Period from Birds which Survive throughout the Year. Professor J. Arthur Harris and Donald C. Boughton.
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Influence of Thyroid Extract and Iodine on Growth and Development. Professor F. E. Chidester, A. G. Eaton and W. M. Insko, Jr.
A Three-eyed Haddock, with Notes on Other Three-eyed Fishes. Dr. E. W. Gudger.
Shorter Articles and Discussion: Two Further Notes on the Origin of Dominance: R. A. Fisher.
Index to Volume LXII.

JANUARY–FEBRUARY

Problems of Development. Edwin Grant Conklin.
Experimental Studies on the Duration of Life. W. W. Alpatov and Raymond Pearl.
The Mechanism of Ciliary Movement. James Gray.
The Mystery of Alabama argillacea. George N. Wolcott.
Shorter Articles and Discussion: Specific Differences between the Amebas Mayorella bigemma and M.(?) dofleini: A. A. Schaeffer. Birds as Hosts for the Common Chigger: H. E. Ewing.

MARCH–APRIL

Neurofibrils. Professor George H. Parker.
The Effect of X-Rays in Producing Somatic Genovariations in Drosophila Melanogaster. N. W. Timofeeff-Ressovsky.
On the Possibility of Indefinite Reproduction in the Ciliate Didinium without Conjugation or Endomixis. Dr. C. Dale Beers.
Hermaphroditism in the Frog. J. H. Lloyd.
The Relation between Length of Styles and Mendelian Segregation in a Maize Cross. Dr. P. C. Mangelsdorf.
The Segregation of Albescent Seedlings and the Mutation to Defective Seeds in a Pedigree of the Japanese Morning Glory. Dr. Yoshitaka Imai.
Larval and Postlarval Lobsters. D. A. MacKay.
Hibernation of the Thirteen-lined Ground Squirrel. Dr. George Edwin Johnson.
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MAY–JUNE

The Cytological Expression of Changes in Gene Alignment Produced by X-Rays in Drosophila. Professor H. J. Muller and Professor T. S. Painter.
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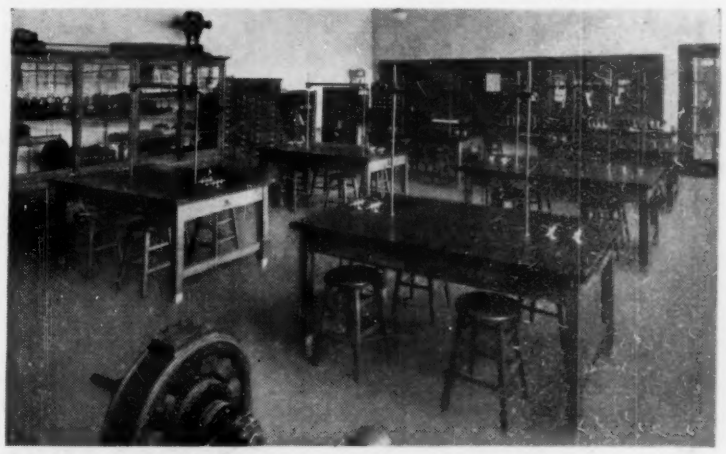

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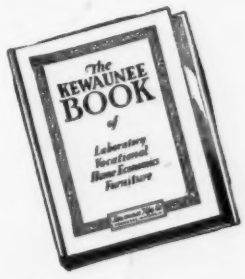

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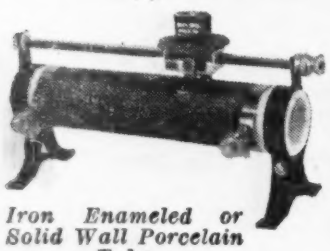
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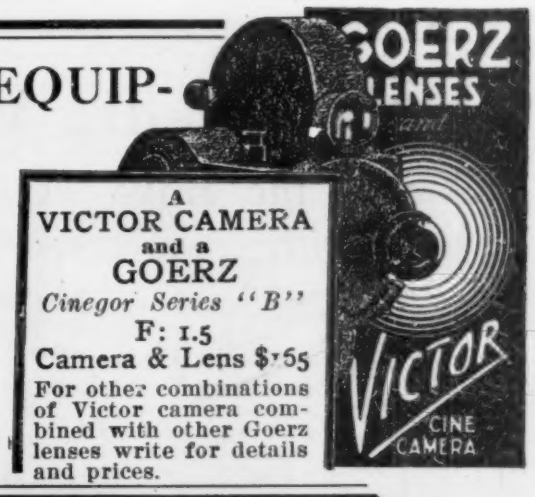

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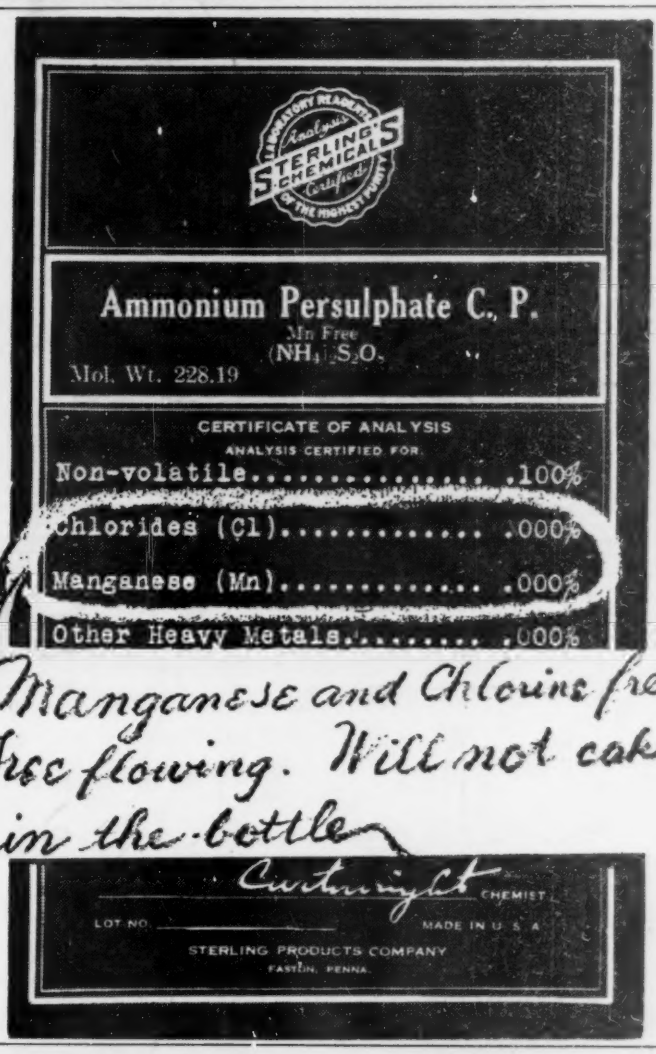

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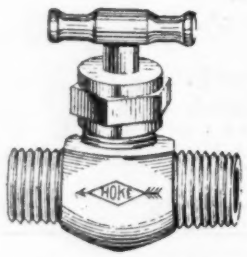

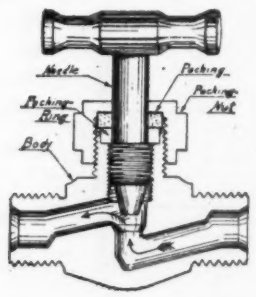

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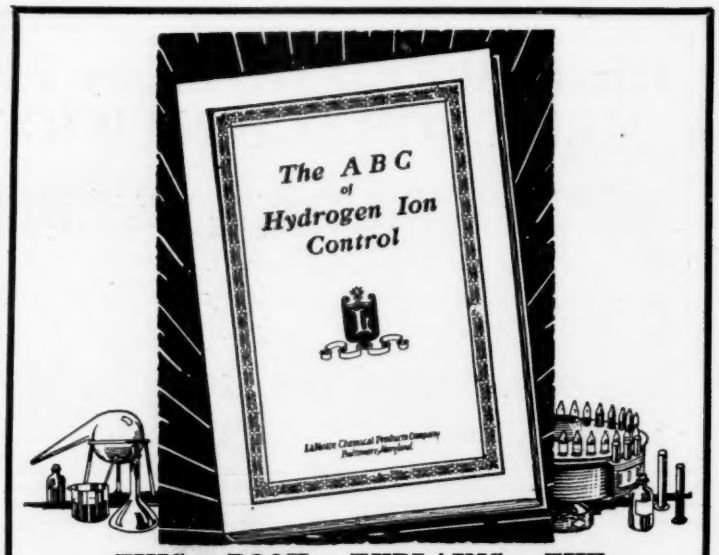

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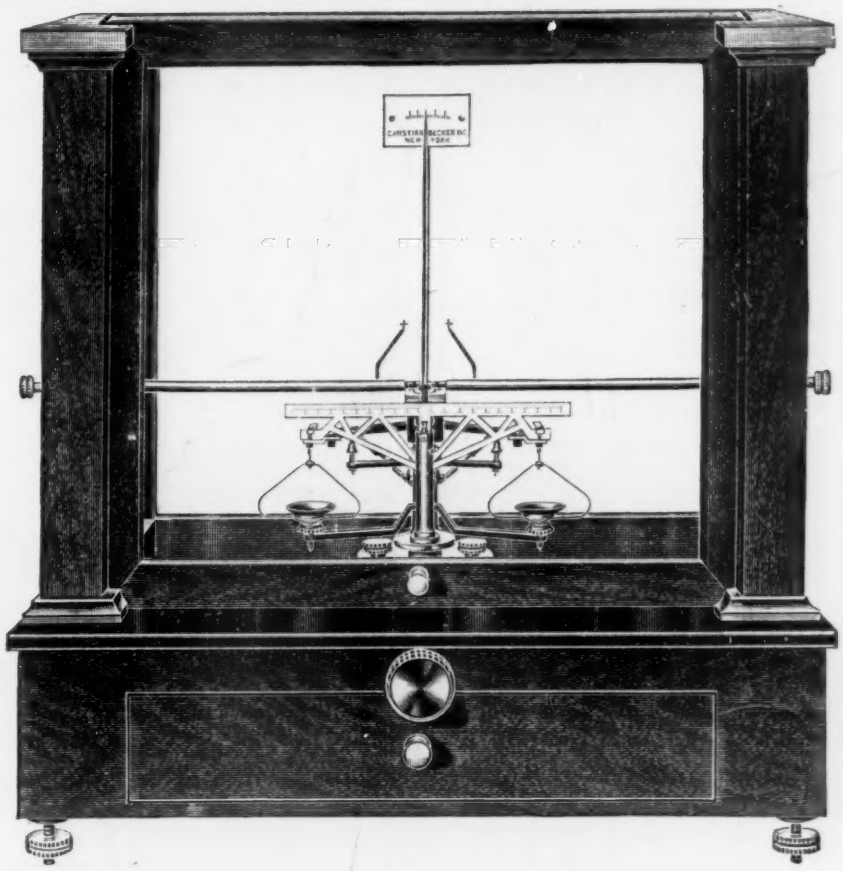

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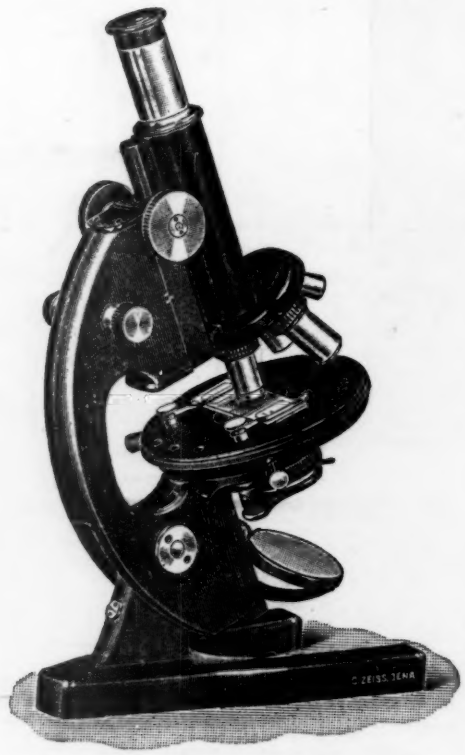

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